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# CONSIDERATIONS FOR PREPARATION OF OPERATION AND MAINTENANCE MANUALS

R. L. Green, et al

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# CONSIDERATIONS FOR PREPARATION OF OPERATION AND MAINTENANCE MANUALS

by

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OPERATION AND MAINTENANCE PROGRAMS

OFFICE OF WATER PROGRAMS OPERATIONS

U. S. ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D. C.

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## EPA Review Notice

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# ABSTRACT

This document provides considerations for the preparation of complete and adequate municipal wastewater treatment plant operation and maintenance (O & M) manuals. Proper utilization of these considerations will assist in complying with the eligibility requirements of the Construction Grant Program of the U. S. Environmental Protection Agency (EPA), as stated in 40 CFR, Part 35, Section 35.935-12 (or any amendments thereto).

Preliminary steps in this work included a revision of the existing guide for an operation and maintenance manual in the Appendix of the "Federal Guidelines For Design, Operation and Maintenance of Waste Water Treatment Facilities", 1970 (to be totally revised in 1973). Existing manuals now being used in municipal wastewater treatment plants were surveyed and persons experienced in plant operation and manual preparation were consulted for advice.

This manual includes a separate section covering each of the chapters recommended for an operation and maintenance manual of a treatment facility. Detailed discussions on the type of information to be included in the operation and maintenance manual are found in each section. A suggested manual outline has been prepared for treatment plants and a second outline has been prepared for pumping stations and pipelines.

The guidelines presented are not intended to be a rigid format; each manual must be modified to the individual situation. However, the availability of a national format should speed manual preparation and review procedures.

This report was submitted in fulfillment of Contract 68-01-0341 under the sponsorship of the Office of Water Programs Operations, Environmental Protection Agency.

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# SECTION I
# CONCLUSIONS

1. The O & M Manuals currently being developed for municipal wastewater treatment systems vary greatly with respect to content and preparation cost. A major reason for this wide variance is that existing manuals have been prepared without the benefit of comprehensive guidance that could be followed regardless of the size and type treatment system. The guidance contained in this manual should be flexible enough to be applicable to any municipal wastewater treatment system.

2. The purpose of an O & M Manual is to give treatment system personnel the proper understanding, techniques and references necessary to efficiently operate their facilities. Many existing manuals contain a few exceptional sections with the remainder of the manual being inadequate. Some manuals have taken the form of engineering reports and are totally inadequate as an O & M document. A few very good manuals have been produced as a result of conscientious and comprehensive effort on the part of experienced operating personnel and sanitary engineers.

3. A problem area common to most existing O & M Manuals is the language style in which they are written. Generally these manuals are written by engineers, critiqued by engineers and approved by engineers. If these manuals are to benefit treatment system operation, they must be aimed at those individuals operating the facilities and not design engineers.

4. A large percentage of current municipal treatment plant construction involves the enlarging and/or upgrading of existing facilities. Many facilities that are being modified either do not have O & M Manuals or have manuals which are inadequate.

5. Persons involved in O & M Manual preparation require timely and accurate information from suppliers of wastewater treatment equipment for incorporation in O & M Manuals. The information should be tailored for the specific equipment item supplied.

6. Consulting engineers generally provide O & M Manuals for their clients on a cost of preparation plus a given percentage of these costs for profit basis. In general, consultants attempt to address all topics listed in the Suggested Guide For An O & M Manual found in the Appendix of "Federal Guidelines, Design, Operation and Maintenance of Waste Water Treatment Facilities," 1970, but not necessarily in the suggested format. The needs and desires of each client play a large part in the detail of the manual.

7. Some existing O & M Manuals do not possess the necessary flexibility to remain viable tools to operating personnel. The manuals are not designed to be modified and, therefore, cannot keep pace with changing treatment system operating and maintenance needs. A manual with too rigid an approach can be obsolete as a result of the changes and modifications that accompany the start-up of treatment facilities.

8. The first O & M Manual produced by an organization generally reflects the learning process accompanying this effort; as a result, preparation costs often are higher than anticipated. As more manuals are produced, cost reductions are realized through the use of standardized manual sections and increased preparation efficiency.

9. Treatment facilities that were not provided with a formal O & M Manual when placed into operation generally accumulate sufficient equipment manufacturer's data to create a makeshift manual. Although this collection of data is better than having no manual, it is not an adequate substitute for a comprehensive O & M Manual.

# SECTION II
# RECOMMENDATIONS

Although every municipal treatment system's O & M Manual must be tailored to that system's special needs, persons developing manuals should be familiar with the guidance contained in this report. Following this guidance will help ensure consideration of all pertinent O & M topics during the development of the manual.

Individuals responsible for O & M Manual development should obtain input from persons experienced in treatment system operations. This input, combined with the design engineer's expertise, is essential to any good manual. If possible, operations input should be obtained from persons with experience in the same processes as those described in the manual.

Persons responsible for O & M Manual preparation and review should encourage organizations such as the Water Pollution Control Federation and the American Society of Civil Engineers to provide opportunities for persons involved in O & M Manual preparation to receive up-to-date training in this area. Improvements in treatment process operating techniques and maintenance procedures are being made continuously. It is important that these new improvements be quickly and efficiently incorporated in all new manuals. Persons responsible for O & M Manual preparation should strive for maximum flexibility in their manuals.

Persons involved in the preparation of the O & M Manual should take the necessary action to insure they obtain timely and accurate operations and maintenance information on all equipment items These actions might simply be enforcement of existing requirements or adding sections to project specifications calling for submittal of preliminary O & M information prior to paying for equipment.

# SECTION III
# INTRODUCTION

## Scope and Purpose

The primary function of municipal wastewater treatment facilities is to collect and treat municipal wastewaters so as to attain an interim national "... goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water." The Federal Water Pollution Control Act Amendments of 1972 stipulate that this is to be accomplished by publicly owned treatment works in a consistent and reliable manner so as to meet effluent limitations based upon secondary treatment or any more stringent applicable limitation, by July 1, 1977, and so as to employ the best practicable waste treatment technology by July 1, 1983. The specific conditions and limitations will be identified in a permit issued to each point source discharge under the "National Pollutant Discharge Elimination System" as established by the Act.

Since the discharge of pollutants in excess of the effluent limitations of discharge permits is prohibited by the Act, it is essential that municipal wastewater plants, from the day of initial operation, effectively treat wastewater in compliance with those limitations. This manual has been prepared to assist in the accomplishment of this objective.

This manual provides considerations for the preparation of a municipal wastewater treatment facility's operation and maintenance manual.

This volume provides a format for the organization of an operation and maintenance manual, describes the type information to be included in these manuals, and provides checklists and examples to assist persons preparing O & M Manuals.

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## Project Phases

The development of these O & M Manual preparation considerations began with concurrence between EPA personnel and Wiley & Wilson, Inc. representatives in the following areas:

1. Tentative revisions to the existing Suggested Guide for an O & M Manual in the "Federal Guidelines, Design, Operation and Maintenance of Waste Water Treatment Facilities", 1970.
2. New requirements for O & M Manuals.
3. Integration of subject areas of other EPA reference manuals now in preparation.
4. Coordination with associated EPA programs.

A survey of existing O & M Manuals was made. A questionnaire was prepared, approved by the Office of Management and Budget, and mailed to over 200 municipal treatment facilities across the country. Field trips were made to selected facilities to evaluate the completeness of their manuals.

Telephone and field conferences were held with persons experienced in the operation and maintenance of treatment systems to discuss O & M Manual preparation. A survey of other operation and maintenance literature was made. Certain subject areas of other EPA manuals now in preparation and several associated EPA programs were reviewed for inclusion in this report.

The results of the survey of existing O & M Manuals, the responses to the questionnaire, the field trips, the conferences, the reviews of associated EPA programs and the input from Wiley & Wilson's sanitary engineering conceptual design team are included in this manual.

## Manual Format

Users of this manual first should become familiar with its Table of Contents. A principal section addresses each of the chapters recommended for operation and maintenance manuals. A supplementary table of contents page has been provided at the beginning of each section to help in locating desired information. Further, the information contained in each section has been condensed into the comprehensive outline form in the section entitled Suggested Guide and Checklist for an Operation and Maintenance Manual for Municipal Wastewater Treatment Facilities. A similar outline has been provided for pumping station and pipeline manuals.

The References section of this manual contains a tabulation which relates existing reference materials to each recommended manual chapter.

Persons preparing O & M Manuals should be cautioned not to simply duplicate pages out of this considerations manual. Information in a facility's O & M Manual should be tailored to the specific needs of that facility.

# SECTION IV
# WRITING SKILLS REQUIRED IN O & M MANUAL PREPARATION

The primary purpose of an O & M Manual is to help ensure the performance record of a treatment system remains high. The manual thus serves as a tool for the operating and maintenance personnel of the plant. The key to a manual's ultimate success is the language used and the writing style.

There are two basic problems to be considered in the preparation of such manuals: First, since most O & M Manuals are prepared by consulting engineering firms, these firms must make certain they obtain information from persons actually experienced in plant operation and maintenance. The problem is to translate the design engineer's concepts into a language form acceptable to operating personnel. Second, the comprehension of the users of the manual must be considered. Because of the technical nature of the wastewater treatment field, a certain level of competence by persons using the manual must be required. Factors determining the competence of manual users might include past performance, operator certification, and available training programs. Individuals preparing an O & M Manual must not overestimate nor underestimate this competence level in their writing.

Some municipal treatment systems are capable of producing their own O & M Manuals. The same writing considerations are demanded as when design engineers prepare the manuals.

These "Considerations for Preparation of Operation and Maintenance Manuals" are written in a style similar to that recommended for O & M Manuals. A further suggested example of writing style for O & M Manuals is found in New York's "Manual of Instruction for Sewage Treatment Plant Operators."

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## SECTION V
## O & M MANUAL ADAPTABILITY TO PLANT ENLARGEMENT AND/OR UPGRADING

A large part of current municipal wastewater treatment plant construction involves plant enlargement and/or upgrading. In this regard, many municipalities either do not have O & M Manuals or their existing manuals are inadequate. Because important emphasis is currently being placed on plant enlargement and/or upgrading, the problems related to adapting O & M Manuals to these situations need to be discussed.

### Plant Enlargement

Treatment facilities are often enlarged by adding units identical to existing treatment units. In such cases, consideration should be given to maintaining the existing O & M Manual. Appendices and addenda can be added to describe the pertinent features of the enlargement. It is imperative that input from persons experienced in the operation of the existing facility be obtained. The existing manual should be thoroughly reviewed and updated as required.

### Plant Upgrading

The upgrading of existing municipal treatment systems is common. This situation presents to the operator a totally new concept in treatment philosophy. It is accompanied by more complex process operations and maintenance requirements. This type of upgrading usually requires the development of a new O & M Manual, although certain sections of the existing manual may find application in the new manual. Input from persons experienced in the new process operations should be obtained.

### Plant Enlargement and Upgrading

One of the most common situations involves enlarging the capacity of a system to meet new loadings together with an upgrading of treatment facilities to protect receiving waters. A new O & M Manual is usually

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required in this situation. Input must be obtained from persons with operational experience. The existing manual should be reviewed thoroughly to determine what sections can be included in the new manual.

Any design provisions for plant enlargement or upgrading should be thoroughly discussed in the O & M Manual. Such provisions might include metering capabilities for future plant flows, flexibility in splitter boxes and excess capacity in plant piping. Some facilities are designed to be expanded by adding more treatment components. The O & M Manual for the original facility can be tailored to receive inserts describing component expansion. This technique will eliminate the need for a completely new manual after plant enlargement. However, at the time these inserts are added, the existing manual should be thoroughly reviewed. Such a review will help to keep the manual current with respect to operational experiences and maintenance techniques.

In some cases, existing treatment units are modified for use in new processes. This situation will require a new process description, operation and control section as a minimum addition to an existing manual. Usually this type of modification requires preparing a new manual.

# SECTION VI

## SUGGESTED GUIDE AND CHECKLIST FOR AN OPERATION AND MAINTENANCE MANUAL FOR MUNICIPAL WASTEWATER TREATMENT FACILITIES

and

## SUGGESTED GUIDE AND CHECKLIST FOR AN OPERATION AND MAINTENANCE MANUAL FOR MUNICIPAL WASTEWATER PUMPING STATIONS AND/OR PIPELINES

The formats presented in this section are intended to be a flexible guide for the preparation of an O & M Manual for a wastewater treatment system and can be modified to fit the particular system at hand. It is anticipated that these formats can be used in most cases. If manual preparation follows these formats, the review process will be greatly accelerated.

Each of the twelve (12) chapters and the appendices in the suggested guide and checklist for wastewater treatment facilities is addressed in a separate section of this manual. In each section, detailed descriptions of the type information required in that respective chapter of the O & M Manual are given.

It should be remembered that the O & M Manual will provide assistance in developing standard operating procedures for each system. The adequacy of these procedures plays a major role in determining how well the system will operate. The O & M Manual should provide the necessary information to insure these standard operating procedures can be readily developed. Once an acceptable set of procedures has been established, the O & M Manual becomes a reference book for the entire treatment system. The information contained in the manual will provide answers to many of the questions that arise frequently in the operation of a wastewater treatment system.

## SUGGESTED GUIDE AND CHECKLIST FOR AN OPERATION AND MAINTENANCE MANUAL FOR MUNICIPAL WASTEWATER TREATMENT FACILITIES

TABLE OF CONTENTS
CHAPTER I. INTRODUCTION

Manual User Guide
Table of Contents

A. Operation and managerial responsibility

  1. Operator responsibility

    a. General - outline responsibilities

      (1) Know proper operational procedures

      (2) Keep accurate records

      (3) Properly manage operating funds

      (4) Keep supervisors informed

      (5) Keep informed of current O & M practices

    b. List short courses and operator schools available

    c. Provide suggested list of journals/periodicals related to municipal wastewater treatment

  2. Treatment system management responsibility - outline responsibilities

    a. Maintain efficient plant operation and maintenance

    b. Maintain adequate records

    c. Establish staff requirements, prepare job descriptions and assign personnel

    d. Provide good working conditions

    e. Establish operator training program

    f. Provide incentives for employees

---

## SUGGESTED GUIDE AND CHECKLIST FOR AN OPERATION AND MAINTENANCE MANUAL FOR MUNICIPAL WASTEWATER PUMPING STATIONS AND/OR PIPELINES

TABLE OF CONTENTS
CHAPTER I. INTRODUCTION

Manual User Guide
Table of Contents

A. Operation and managerial responsibility

  1. Operator responsibility

    a. General - outline responsibilities

      (1) Know proper operational procedures

      (2) Keep accurate records

      (3) Properly manage operating funds

      (4) Keep supervisors informed

      (5) Keep informed of current O & M practices

    b. List short courses and operator schools available

    c. Provide suggested list of journals/periodicals related to municipal wastewater treatment

  2. Treatment system management responsibility - outline responsibilities

    a. Maintain efficient plant operation and maintenance

    b. Maintain adequate records

    c. Establish staff requirements, prepare job descriptions and assign personnel

    d. Provide good working conditions

    e. Establish operator training program

    f. Provide incentives for employees

g. Maintain good public relations

h. Prepare budgets and reports

i. Plan for future facility needs

j. Develop standard operating procedures

B. Type of treatment and treatment requirements/effluent limitations

1. Type treatment - Describe major process

a. Primary

b. Secondary - trickling filter

c. Secondary - activated sludge

d. Other

2. Treatment requirements/effluent limitations - state whether monthly or yearly averages are used

a. Biochemical oxygen demand (BOD)

b. Suspended solids concentration

c. pH

d. Other

C. Description of plant type and flow pattern

1. Plant type - Briefly describe individual units

a. Pretreatment

b. Primary treatment

c. Secondary treatment

d. Disinfection

e. Sludge handling

2. Flow Pattern

a. Include a basic flow diagram

b. Bypasses and alternate flow paths can generally be omitted from this introductory diagram

g. Maintain good public relations

h. Prepare budgets and reports

i. Plan for future facility needs

j. Develop standard operating procedures

B. Description of pumping stations and/or pipeline type

1. Pumping station type - Describe station type

a. Municipal wastewater

b. Storm water runoff

c. Industrial wastes

d. Combined municipal & storm water

e. Sludge

f. Treated municipal wastewater

2. Pumping station classification - Discuss how station is classified

a. Capacity (gpm, mgd)

b. Energy source (Primary and Stand-by)

(1) Electric

(2) Diesel

(3) Steam

(4) Other

c. Construction method

3. Discuss pumping station chlorination facilities

4. Pipeline types and sizes - Describe pipeline

a. Asbestos-cement

b. Brick masonry

c. Clay

d. Concrete

## CHAPTER II. PERMITS AND STANDARDS
Table of Contents

A. Discharge permit and permit requirements
   1. Give permit number
   2. Give renewal date if applicable
   3. List permit requirements
   4. Include permit application guidelines
   5. Copy of Federal/State laws or agency regulations dealing with municipal wastewater discharge permits should be included

B. Reporting procedure for spills of raw or inadequately treated wastewater
   1. Include copies of Federal/State laws and/or agency regulations requiring reporting of bypass/spill condition
      a. Discuss owner's responsibilities
      b. Discuss penalties
   2. Outline reporting procedure to include telephone numbers and sample report format

      e. Iron and Steel
         (1) Cast iron
         (2) Ductile iron
         (3) Fabricated steel
   5. Describe type of joint used
   6. Discuss pipeline appurtenances and special structures
      a. Manholes
      b. Check valves and relief overflows
      c. Siphons
      d. Flap gates
      e. Metering stations
      f. Air relief valves
      g. Other

## CHAPTER II. PERMITS AND STANDARDS
Table of Contents

A. Permit and permit requirements
   1. Give permit number
   2. Give renewal date if applicable
   3. List permit requirements
   4. Include permit application guidelines
   5. Include copy of Federal/State laws or agency regulations dealing with pumping station permits

B. Reporting procedure for spills of raw or inadequately treated wastewater
   1. Include copies of Federal/State laws and/or agency regulations requiring reporting of bypass/spill condition
      a. Discuss owner's responsibilities
      b. Discuss penalties
   2. Outline reporting procedure to include telephone numbers and sample report format

C. Water Quality Standards

1. Provide copy of State's Quality Standards for receiving stream for treatment plant's effluent
2. Provide copy of State's stream classification system

## CHAPTER III. DESCRIPTION, OPERATION AND CONTROL OF WASTEWATER TREATMENT FACILITIES

Table of Contents

A. General - Each major wastewater treatment unit/process should be discussed separately with respect to the following considerations:

1. Description
    a. Provide a brief general description with each major treatment unit/process discussed
        (1) Pretreatment
        (2) Primary sedimentation
        (3) Biological processes
        (4) Secondary sedimentation
        (5) Disinfection
        (6) Other
    b. The description should physically trace the wastewater through the unit/process and comment on design efficiency
2. Relationship to adjacent units
    a. Give type and function of any or all preceding units/processes as they relate to unit/process being considered
    b. Give type and function of any or all following units/processes as they relate to unit/process being considered

C. Water Quality Standards for adjacent water courses

1. Provide copy of State's Quality Standards for any water courses adjacent to pumping stations or pipelines, where there is a potential for a spill of raw wastewater
2. Provide copy of State's stream classification system

## CHAPTER III. DESCRIPTION, OPERATION AND CONTROL OF PUMPING STATIONS AND/OR PIPELINES

Table of Contents

A. General

1. Pumping station description - Provide a brief general description of the pumping station
    a. Typical
    b. Package
    c. Pneumatic-ejector
    d. Other
2. Pipeline description - Provide a brief general description of the pipeline
    a. Gravity
    b. Force Main
3. Pumping station major components - List major components
    a. Pumps
    b. Suction and discharge piping
    c. Wet well
    d. Automatic Controls
    e. Other
4. Pipeline major components - List major components
    a. Pipe
    b. Manholes

3. Classification and Control
    - a. Classification - Briefly describe relation to similar units/processes
        - (1) Standard/conventional
        - (2) Modified
        - (3) Other
    - b. Control - give methods of controlling unit/process
        - (1) Flow to Plant
        - (2) Recirculation Pumps
        - (3) Air Supply
        - (4) Sludge Return/Wasting Rates
        - (5) Other (Physical and process controls)

4. Major components
    - a. List all components within the unit/process
    - b. List all major mechanical equipment items within the unit/process
    - c. Other

5. Common operating problems
    - a. State problems that might occur in unit/process
    - b. List probable causes
    - c. Discuss control/prevention techniques

6. Laboratory Controls
    - a. List tests and give expected ranges for test results
    - b. Give relation between test results and treatment unit/process operation

7. Start-up - give start-up techniques

B. Specific Plant Operation

1. Normal Operation

    - c. Siphons
    - d. Metering stations
    - e. Other

5. Pumping Station and/or Pipelines - Common Operating/Maintenance Problems
    - a. State problems
    - b. List probable causes
    - c. Give control/prevention techniques

6. Pumping Stations and/or Pipelines Start-up - give start-up techniques

B. Specific Pumping Station and/or Pipeline Operation

1. Normal Operation
    - a. Discuss the normal operation of each type pumping station and/or pipeline
        - (1) Pump settings
        - (2) Valve positions
        - (3) Flow meter settings
        - (4) Chlorination system
        - (5) Other

2. Alternate Operation
    - a. List alternative modes of operation
    - b. Provide discussion and schematics to illustrate alternate operation

3. Emergency Operations and Failsafe Features
    - a. Discuss emergency operating procedures for potential emergency conditions
    - b. List failsafe features
    - c. Describe operation of failsafe features

a. Discuss the normal operation of each unit/process. This discussion should include the following information as it may apply to the particular unit/process

   (1) Valve positions

   (2) Sluice gate settings

   (3) Weir elevations

   (4) Sludge rake speeds

   (5) Pump settings

   (6) Recirculation rates

   (7) MLSS concentrations

   (8) Other

2. Alternate Operation

   a. List alternate modes of operation

   b. Provide discussion and schematics to illustrate alternate operations

3. Emergency Operations and Failsafe Features

   a. Discuss emergency operating procedures for potential emergency conditions

   b. List failsafe features

   c. Describe operation of failsafe features

## CHAPTER IV. DESCRIPTION, OPERATION AND CONTROL OF SLUDGE HANDLING FACILITIES

Table of Contents

A. General - each major sludge handling unit/process should be discussed separately with respect to the following considerations:

   1. Description

      a. Provide a brief general description with each major unit/process discussed

         (1) Concentration/thickening

        (2) Digestion
        (3) Conditioning
        (4) Dewatering/drying
        (5) Incineration
        (6) Wet oxidation
        (7) Disposal
        (8) Other
    b. The description should physically trace the sludge through the unit/process and comment on how the character of the sludge is altered

2. Relationship to adjacent units
    a. Describe type and function of any or all preceding units/processes as they relate to unit/process being considered
    b. Describe type and function of any or all following units/processes as they relate to process being considered

3. Classification and control
    a. Classification - Describe relation to similar units/processes
        (1) Standard/conventional
        (2) Modified
        (3) Other
    b. Control - Give methods of controlling unit/process
        (1) Recirculation Pumps
        (2) Aerobic Digestion Air Supply
        (3) Conditioning Chemicals
        (4) Temperature
        (5) Other

4. Major components
    a. List all components within the unit/process

        - b. List all major mechanical equipment items within the unit/process
        - c. Other
    - 5. Common operating problems
        - a. State problems that might occur in unit/process
        - b. List probable causes
        - c. Discuss control/prevention techniques
    - 6. Laboratory controls
        - a. List tests and give expected ranges for test results
        - b. Give relation between test results and treatment process operation
    - 7. Start-up - give start-up techniques
- B. Specific Plant Operation
    - 1. Normal operation
        - a. Discuss the normal operation of each unit/process. This discussion should include the following information as it may apply to the particular unit/process
            - (1) Valve positions
            - (2) Heat requirements
            - (3) Sludge blanket depths
            - (4) Sludge pumping schedule
            - (5) Sludge collector/stirring speeds
            - (6) Vacuum filter hours of operation
            - (7) Other
    - 2. Alternate Operation
        - a. List alternate modes of operation
        - b. Provide discussion and schematics to illustrate alternate operations
    - 3. Emergency operations and failsafe features

    a. Discuss emergency operating procedures for potential emergency conditions

    b. List failsafe features

    c. Describe operation of failsafe features

## CHAPTER V. PERSONNEL
Table of Contents

A. Manpower Requirements/Staff - List personnel required

  1. Supervisors

  2. Administrative

  3. Operational

  4. Maintenance

B. Qualifications

  1. For each job title give:

    a. Training

    b. Experience

    c. Skills required

    d. License/certificate required

C. Certification Program

  1. Include copy of State Certification Board's Rules and Regulations

  2. Discuss pertinent aspects of operator certification as they apply to the facility at hand

## CHAPTER VI. LABORATORY TESTING
Table of Contents

A. Purpose - discuss purpose of laboratory testing

  1. Essential to treatment process control

  2. Provides an operating record for treatment system

  3. Aids in problem analysis and prevention

CHAPTER IV. PERSONNEL
Table of Contents

A. Manpower Requirements/Staff - List personnel required

  1. Supervisors

  2. Administrative

  3. Operational

  4. Maintenance

B. Qualifications

  1. For each job title give:

    a. Training

    b. Experience

    c. Skills required

    d. License/certificate required

C. Certification Program

  1. Include copy of State Certification Board's Rules and Regulations

  2. Discuss pertinent aspects of operator certification as they apply to the facility at hand

B. Sampling

1. Give grab sample definition
2. Give composite sample definition
3. Outline a sampling program for the treatment system

C. Laboratory References - List pertinent references

1. WPCF MOP No. 18, Simplified Laboratory Procedures for Wastewater Examination
2. Standard Methods for the Examination of Water and Sewage
3. Other

D. Interpretation of Laboratory Tests - give brief definition and sanitary engineering application for all tests

1. pH
2. Dissolved oxygen (DO)
3. Biochemical oxygen demand (BOD)
4. Settleable and suspended solids - discuss importance of solids balance
5. Chlorine residual
6. Other

E. Sample Laboratory Worksheets - give instructions for completing sample forms

1. Solids determinations
2. BOD determinations
3. Other

## CHAPTER VII. RECORDS
Table of Contents

A. Process Operations/Daily Operating Log - provide sample form and discuss features

1. Weather conditions
2. Facility influent flow

## CHAPTER V. RECORDS
Table of Contents

A. Process Operations/Daily Operating Log - Provide sample form and discuss features

1. Routine operational duties
2. Power consumption

3. Recirculation rate

4. Grit removed

5. Sludge handling data

6. Status of secondary treatment process

7. Operators on duty

8. Complaints received

9. Plant visitors

10. Power consumption

11. Chemicals used

12. Unusual conditions (operational and maintenance)

13. Routine operational duties

B. Laboratory - Comprehensive discussion of laboratory records should be included under laboratory controls chapter of the manual

C. Monthly Report to State Agencies

1. Provide sample form

2. Give instructions for completing form

3. Outline techniques for maximum utilization of State forms to eliminate using any supplemental forms

4. Tell when and where to submit completed forms

D. Annual Report

1. Designate individual responsible for preparing report

2. State whether calendar or fiscal year summary

3. Give sample report format

a. Annual summary of operating data

b. Annual summary of management data

4. Provide coordinating instructions with financial arm of parent Governmental body

3. Unusual conditions

4. Chemicals used

5. Other

B. Monthly Report to State Agencies

1. Provide sample form

2. Give instructions for completing form

3. Outline techniques for maximum utilization of State forms to eliminate using any supplemental forms

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3. Give sample report format

a. Annual summary of operating data

b. Annual summary of management data

4. Provide coordinating instructions with financial arm of parent Governmental body

D. Maintenance - Comprehensive discussion of maintenance records should be included under maintenance chapter of the manual

E. Operating Costs and Record Keeping - list and discuss each major cost group and record keeping procedures for each

1. Labor

a. Operation

b. Administration

c. Maintenance

2. Utilities

a. Electricity

E. Maintenance - Comprehensive discussion of maintenance records should be included under maintenance chapter of the manual

F. Operating Costs and Record Keeping - list and discuss each major cost group and record keeping procedure for each

1. Labor
   - a. Operation
   - b. Administration
   - c. Maintenance
2. Utilities
   - a. Electricity
   - b. Fuel oil
   - c. Potable water
   - d. Telephone
   - e. Other
3. Chemicals (Process only)
   - a. Lime
   - b. Alum
   - c. Chlorine
   - d. Other
4. Supplies
   - a. Laboratory chemicals
   - b. Cleaning materials
   - c. Maintenance materials
   - d. Other expendable items

G. Personnel Records

H. Emergency Conditions Record
   - a. Bypass report
   - b. Deteriorated effluent record
   - c. Other

   - b. Fuel oil
   - c. Potable water
   - d. Telephone
   - e. Other
3. Chemicals
   - a. Chlorine
   - b. Lime
   - c. Other
4. Supplies
   - a. Cleaning materials
   - b. Maintenance materials
   - c. Other expendables

F. Personnel Records

G. Emergency Conditions Record
   - a. Bypass report
   - b. Other

## CHAPTER VII. MAINTENANCE
Table of Contents

A. General

  1. State purpose of maintenance system
  2. Outline scope of recommended maintenance system
  3. List basic features
    a. Equipment record system
    b. Planning and scheduling
    c. Storeroom and inventory system
    d. Maintenance personnel
    e. Cost and budgets for maintenance operations

B. Equipment Record System

  1. Describe equipment numbering system
  2. Outline equipment catalog
  3. Discuss the type information and equipment data which should be maintained
  4. Provide instructions on preparing and filing information in the record system
  5. Describe data retrieval system
  6. Provide completed equipment nameplate data cards for each item of equipment
  7. Other

C. Planning and Scheduling

  1. Provide guidelines for preventive maintenance and corrective maintenance tasks
  2. Describe schedule chart board
  3. Outline work order system
    a. Provide sample forms
    b. Describe work order log
  4. Discuss contract maintenance work

## CHAPTER VI. MAINTENANCE
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A. General

  1. State purpose of maintenance system
  2. Outline scope of recommended maintenance system
  3. List basic features
    a. Equipment record system
    b. Planning and scheduling
    c. Storeroom and inventory system
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  5. Describe data card retrieval system
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  7. Other

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  1. Provide guidelines for preventive maintenance and corrective maintenance tasks
  2. Describe schedule chart board
  3. Outline work order system
    a. Provide sample forms
    b. Describe work order log
  4. Discuss contract maintenance work

5. Other

D. Storeroom and Inventory System

1. Recommend spare parts/components to be maintained

2. Outline stockroom inventory procedures

a. Numbering system for all items

b. Sample withdrawal slip

c. Maximum/minimum quantities to be maintained

d. Record system

3. Discuss purchase orders

4. Other

E. Maintenance Personnel

1. Outline maintenance staff

2. Review maintenance staff capabilities and limitations

F. Cost and Budgets for Maintenance Operations

1. Discuss importance of separation of maintenance costs

a. Preventive maintenance

b. Corrective maintenance

c. Major repairs or alterations

2. Suggest a cost accounting system for storeroom stock, special purchase items and man-hours

3. Other

G. Miscellaneous Maintenance Records

1. Provide sample preventive/corrective maintenance log

2. Give breakdown report format

3. Other

H. Housekeeping - discuss housekeeping activities

1. Yard work

2. Painting

5. Other

D. Storeroom and Inventory System

1. Recommend spare parts/components to be maintained

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G. Miscellaneous Maintenance Records

1. Provide sample preventive/corrective maintenance log

2. Give breakdown report format

3. Other

H. Housekeeping - discuss housekeeping activities

1. Yard work

2. Painting

3. General cleaning
4. Other

I. Special Tools and Equipment
    1. Outline tool room procedures
        a. Tool inventory
        b. Tool check control system
    2. Discuss use of tool boards
        a. Special/frequently used tools
        b. Location of boards
    3. Give maintenance skills required for all special tools

J. Lubrication
    1. Give lubrication specifications
    2. Provide interchangeable lubricants chart
    3. Discuss use of color coded lubrication tags for all equipment
    4. Give sample consumption/inventory records
    5. Outline sample lubrication route

K. Major Equipment Information
    1. List all major equipment items
        a. Comminutors
        b. Grit chambers
        c. Sedimentation tanks
        d. Aerators
        e. Pumps
        f. Digesters
        g. Drying beds
        h. Lagoons
        i. Other
    2. Outline basic maintenance considerations for all major electrical and mechanical equipment items

3. General cleaning
4. Other

I. Special Tools and Equipment
    1. Outline tool room procedures
        a. Tool inventory
        b. Tool check control system
    2. Discuss use of tool boards
        a. Special/frequently used tools
        b. Location of boards
    3. Give maintenance skills required for all special tools

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    1. Give lubrication specifications
    2. Provide interchangeable lubricants chart
    3. Discuss use of color coded lubrication tags for all equipment
    4. Give sample consumption/inventory records
    5. Outline sample lubrication route

K. Major Equipment Information
    1. List all major equipment items
    2. Outline basic maintenance considerations for all major electrical and mechanical equipment items
    3. Outline procedure for ordering parts/components or new items

L. Warranty Provisions
    1. List all guaranteed equipment
    2. Give guarantee period for each piece of equipment
    3. Discuss pertinent features of each guarantee

M. Contract Maintenance
    1. Provide list of suggested contract jobs

3. Outline procedure for ordering parts/components or new items

L. Warranty Provisions

1. List all guaranteed equipment

2. Give guarantee period for each piece of equipment

3. Discuss pertinent features of each guarantee

M. Contract Maintenance

1. Provide list of suggested contract jobs

2. Provide list of suggested contractors

## CHAPTER IX. EMERGENCY OPERATING AND RESPONSE PROGRAM

Table of Contents

A. Give results of vulnerability analysis of system

B. List methods to reduce system vulnerability

C. List mutual aid agreements

D. Include emergency equipment inventory

E. Give method of preserving treatment system records

F. Include industrial waste inventory/monitoring system

G. Give coordinating instructions for local police and fire departments

H. Define responsibilities of treatment system personnel

I. Designate an emergency response center

J. List auxiliary personnel requirements

K. Provide a mechanism for ensuring plan is updated periodically

## CHAPTER X. SAFETY

Table of Contents

A. General

2. Provide list of suggested contractors

## CHAPTER VII. EMERGENCY OPERATING AND RESPONSE PROGRAM

Table of Contents

A. Give results of vulnerability analysis of system.

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I. Designate an emergency response center

J. List auxiliary personnel requirements

K. Provide a mechanism for ensuring plan is updated periodically

## CHAPTER VIII. SAFETY

Table of Contents

A. General

1. Management's responsibility - discuss responsibilities
    a. Communicate safety information to employees
    b. Eliminate hazardous working conditions
    c. Motivate employees to be safety minded
    d. Other
2. Emergency telephone numbers - provide a list of all numbers
    a. Hospital
    b. Fire station
    c. Ambulance Service
    d. Chlorine supplier
    e. Other

B. Sewers - discuss safety aspects of sewer maintenance
    1. Work site protection
    2. Gas testing equipment
    3. Nonsparking tools
    4. Other

C. Electrical Hazards
    1. Discuss grounding of electric tools
    2. Outline first aid for electric shock victim
    3. Designate authorized personnel to perform electrical repairs
    4. Other

D. Mechanical Equipment Hazards
    1. Discuss equipment guards
    2. Discuss noise level considerations
    3. Designate authorized personnel to perform mechanical repairs
    4. Other

1. Management's responsibility - discuss responsibilities
    a. Communicate safety information to employees
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D. Mechanical Equipment Hazards
    1. Discuss equipment guards
    2. Discuss noise level considerations
    3. Designate authorized personnel to perform mechanical repairs
    4. Other

E. Explosion and Fire Hazards

1. Discuss storage of flammable materials
2. Give type and location of fire extinguishers
3. Discuss use of flammable vapor detectors
4. Outline hazards associated with digester gases
5. Other

F. Bacterial Infection (Health Hazards)

1. State policy on tetanus shots
2. Outline personal hygiene considerations
3. State policy on care of cuts and other injuries
4. Other

G. Chlorine Hazards

1. Discuss cylinder handling
2. Outline procedure for testing for and responding to leaks
3. Describe self-contained breathing apparatus use
4. Other

H. Oxygen Deficiency and Noxious Gases

1. Outline noxious gas testing procedures
2. Discuss ventilating eouipment
3. Provide tabulation of common gases encountered in wastewater treatment systems
4. Other

I. Laboratory Hazards

1. Discuss volatile materials handling
2. Describe protective clothing and devices

E. Explosion and Fire Hazards

1. Discuss storage of flammable materials
2. Give type and location of fire extinguishers
3. Discuss use of flammable vapor detectors
4. Other

F. Bacterial Infection (Health Hazards)

1. State policy on tetanus shots
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4. Other

J. Oxygen Deficiency and Noxious Gases

1. Outline noxious gas testing procedures
2. Discuss ventilating equipment
3. Provide tabulation of common gases encountered in wastewater treatment systems
4. Other

I. Safety Equipment - list safety equipment required

1. First aid kits
2. Fire extinguishers
3. Gas masks/air packs
4. Protective clothing and hard hats

3. Discuss proper ventilation

4. Other

J. Safety Equipment - list safety equipment required

1. First aid kits

2. Fire extinguishers

3. Gas masks/air packs

4. Protective clothing and hard hats

5. Safety harnesses

6. Other

K. Process Chemical Handling - discuss procedures for all chemicals used

1. Alum

2. Lime

3. Ferric Chloride

4. Ferrous Sulfate

L. References - list pertinent safety references

1. WPCF MOP #1 - Safety in Wastewater Works

2. WPCF MOP #18 - Operation of Wastewater Treatment Plants

3. Chlorine Institute, Chlorine Manual

4. EPA Manual - Safety in the Design Operation and Maintenance of Wastewater Treatment Works, Contract No. 68-01-0324

5. Other

CHAPTER XI. UTILITIES
Table of Contents

A. General

1. Give name of utility company

2. List contact men within utility company

5. Safety Harnesses

6. Other

J. Process Chemical Handling - discuss procedures for all chemicals used

K. References - list pertinent safety references

1. WPCF MOP #1 - Safety in Wastewater Works

2. WPCF MOP #7 - Sewer Maintenance

3. Chlorine Institute, Chlorine Manual

4. EPA Manual - Safety in the Design, Operation and Maintenance of Wastewater Treatment Works, Contract No. 68-01-0324

5. Other

CHAPTER IX. UTILITIES
Table of Contents

A. General

1. Give name of utility company

2. List contact men within utility company

    - a. Routine contact
    - b. Emergency contact
  - 3. Discuss reliability of service
  - 4. Give any cost information available
- B. Electrical
  - 1. Give voltage of service adjacent to facility
  - 2. Give reduced voltage entering facility
  - 3. Discuss stand-by power from a second source
- C. Telephone
  - 1. Outline telephone communications system within treatment system
  - 2. Discuss any alarm systems that utilize telephone wires
- D. Natural Gas
  - 1. Give cubic feet of gas per hour
  - 2. Give normal operating pressure
  - 3. Give size of gas line
- E. Water
  - 1. Give size of waterline
  - 2. Give normal operating pressure
  - 3. Discuss any backflow preventer prevention systems present
- F. Fuel Oil
  - 1. List capacities of storage tanks
  - 2. Outline program to insure adequate supplies of fuel oil are always on hand
  - 3. List potential suppliers

CHAPTER XII. ELECTRICAL SYSTEM -
Describe the Electrical System
Table of Contents

- A. General
  - 1. Schematic diagrams

    - a. Routine contact
    - b. Emergency contact
  - 3. Discuss reliability of service
  - 4. Give any cost information available
- B. Electrical
  - 1. Give voltage of service adjacent to facility
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  - 1. List capacities of storage tanks
  - 2. Outline program to insure adequate supplies of fuel oil are always on hand
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CHAPTER X. ELECTRICAL SYSTEM -
Describe the Electrical System
Table of Contents

- A. General
  - 1. Schematic diagrams

2. Tables

3. Manufacturer's literature

4. Shop drawings

5. Designer's notes

B. Power Source

1. Give name of electrical utility company

2. Give characteristics of primary distribution line

3. Describe main transformer and state ownership

4. Discuss protective devices

5. Give maximum available short-circuit current at point(s) of service from utility company

C. Power Distribution System

1. Describe service entrance equipment

2. Describe motor control centers and control panels

3. Provide tabulations indicating power wiring from and loads fed by major electrical components

D. Control and Monitoring System

1. Provide tabulations of type controls present and process equipment involved

2. Provide schematic diagrams

E. Alternate Power Source

1. Describe power source

2. Describe any duplicate equipment in the power distribution system

APPENDICES
Table of Contents

A. Schematics - provide as required

1. Basic flow diagrams

2. Process flow sheets

2. Tables

3. Manufacturer's literature

4. Shop drawings

5. Designer's notes

B. Power Source

1. Give name of electrical utility company

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E. Alternate Power Source

1. Describe power source

2. Describe any duplicate equipment in the power distribution system

APPENDICES
Table of Contents

A. Schematics - provide as required

1. Basic flow diagrams

2. Bypass piping diagrams

3. Bypass piping diagrams
4. Hydraulic profile
5. Other

B. Valve Indices - describe all major valves
   1. Function
   2. Type/size
   3. Location
   4. Identification

C. Sample Forms - provide as required
   1. Daily Operating Log
   2. Equipment Data Cards
   3. Maintenance Work Order
   4. Purchase Order
   5. Accident Report Form
   6. State Reports
   7. Other

D. Chemicals Used in Plant
   1. List all chemicals
   2. Give safety precautions and outline storage considerations in Safety Chapter of Manual
   3. List suppliers
   4. Provide reorder schedule

E. Chemicals Used in Laboratory
   1. Give common name
   2. Give chemical formula
   3. List suppliers

F. Emergency Operating and Response Program - provide as required
   1. Schematic diagrams
   2. Sample forms

G. Detailed Design Criteria - tabulate criteria

3. Hydraulic profile
4. Other

B. Valve Indices - describe all major valves
   1. Function
   2. Type/Size
   3. Location
   4. Identification

C. Sample Forms - provide as required
   1. Daily Operating Log
   2. Equipment Data Cards
   3. Maintenance Work Order
   4. Purchase Order
   5. Accident Report Form
   6. State Reports
   7. Other

D. Chemicals Used in System
   1. List all chemicals
   2. Give safety precautions and outline storage considerations in Safety Chapter of Manual
   3. List suppliers
   4. Provide reorder schedule

E. Emergency Operating and Response Program - provide as required
   1. Schematic diagrams
   2. Sample forms

F. Detailed Design Criteria - tabulate criteria
   1. Population served
   2. Wastewater volume
   3. Line size and capacities
   4. Pump sizes and capacities
   5. Pumping characteristics

1. Population served
2. Wastewater volume/strength
   a. Present/future
   b. Domestic
   c. Industrial
3. Quantities of screenings, grit and sludge removed per million gallons of wastewater treated
4. Unit sizes and capacities
5. Hydraulic and organic loadings
6. Detention times
7. Pumping characteristics
8. Sludge treatment and disposal data

H. Equipment Suppliers
1. Give name
2. List equipment furnished
3. Give reference to where detail information on representatives can be found in manual

I. Manufacturers' Manuals
1. May be bound separately
2. Manuals should give adequate operating and maintenance instructions
3. Manuals should be indexed/cross-referenced

J. Sources for Service and Parts
1. List service organizations for all equipment
2. List local repair services
   a. Meter repair
   b. Motor rewinding
   c. Other
3. List local parts sources
   a. Plumbing wholesalers

6. Other

G. Equipment Suppliers
1. Give name
2. List equipment furnished
3. Give reference to where detail information on representatives can be found in manual

H. Manufacturers' Manuals
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2. List local repair services
   a. Meter repair
   b. Motor rewinding
   c. Other
3. List local parts sources
   a. Plumbing wholesalers
   b. Electrical wholesalers
   c. Mill supply houses
   d. Other

J. As-Built Drawings
1. Ensure drawings are complete and accurate
2. Cross-reference with shop drawings

K. Approved Shop Drawings
1. Index adequately
2. Cross-reference with engineering drawings and construction specifications

L. Dimension Prints

    b. Electrical wholesalers
    c. Mill Supply Houses
    d. Other

K. As-Built Drawings
  1. Ensure drawings are complete and accurate
  2. Cross-reference with shop drawings

L. Approved Shop Drawings
  1. Index adequately
  2. Cross-reference with engineering drawings and construction specifications

M. Dimension Prints
  1. Provide when necessary to show units relation to other units, adjacent walls, etc.
  2. Use to tie shop drawings to engineering drawings

N. Construction Photos
  1. Label and date all photos
  2. Outline photo indexing system

O. Warranties and Bonds
  1. Provide copies
  2. Index properly

P. Copies of State Reporting Forms - provide as required
  1. Monthly Operating Report
  2. Bypass Report
  3. Chlorine Failure Report
  4. Other

Q. Copies of Federal Inspection Forms - provide as required
  1. EPA Form 7500-5 (4-72)
  2. Other

  1. Provide when necessary to show units relation to other units, adjacent walls, etc.
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  2. Bypass Report
  3. Chlorine Failure Report
  4. Other

P. Copies of Federal Inspection Forms - provide as required

Q. Infiltration Controls
  1. Provide copy of existing ordinance
  2. Provide model ordinance if none exists

R. Industrial Waste Controls
  1. Provide copy of existing ordinance
  2. Provide model ordinance if none exists

S. Piping Color Codes
  1. List color for each piping system
  2. State if directional flow arrows and/or labeling required

T. Painting
  1. Give type coating required for each unit
  2. Give painting frequency schedule

R. Infiltration Controls

   1. Provide copy of existing ordinance

   2. Provide model ordinance if none exists

S. Industrial Waste Controls

   1. Provide copy of existing ordinance

   2. Provide model ordinance if none exists

T. Piping Color Codes

   1. List color for each piping system

   2. State if directional flow arrows and/or labeling required

U. Painting

   1. Give type coating required for each unit

   2. Give painting frequency schedule

   3. Provide a copy of Water Pollution Control Federation, MOP-17, "Paints and Protective Coatings", (1969)

V. References to be maintained at treatment facility

   1. MOP #1

   2. MOP #11

   3. Suggested references for detailed study of process utilized

   4. Other

3. Provide a copy of Water Pollution Control Federation, MOP-17, "Paints and Protective Coatings", (1969)

# SECTION VII

## O & M MANUAL CHAPTER I: INTRODUCTION*

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*The format suggested for the table of contents page for the Introduction Chapter of an O & M Manual is similar, except for the manual table of contents discussion, to the format given for this section of the Considerations Manual.

## MANUAL TABLE OF CONTENTS

A clear and complete table of contents is essential in any reference book or manual. A municipal wastewater treatment facility's operation and maintenance manual should contain a table of contents to assist manual users to locate information efficiently. The table of contents format should have all O & M Manual chapters listed and should give sufficient subsections in each chapter to permit easy identification of topics addressed in the manual.

## MANUAL USER GUIDE

An operation and maintenance manual is a treatment system's primary reference book. Because the manual will be used by plant personnel as a reference book, it is essential that desired information be found quickly. The manual's table of contents page should be supplemented by a user guide to help personnel become familiar with the manual's format. The user guide should explain the manual's organization and its intended use.

## OPERATION AND MANAGERIAL RESPONSIBILITY

To insure efficient and economical municipal wastewater treatment system operation, the responsibilities of both the operational personnel and the system's management must be clearly defined. The problems confronting each group must be fully understood by both parties. The operation and managerial responsibility section of the facility's O & M Manual can be used to outline the scope of responsibility for each party.

In any employer-employee relationship, there should be a mutual understanding of the objectives and requirements of the work to be performed.

The following is a suggested list of the operational personnel's responsibilities:

1. Know proper operational procedures.
2. Operate the treatment system effectively.
3. Keep continuously informed of the best operating and maintenance practices.
4. Participate in short courses and schools when available.
5. Subscribe to and regularly read several of the periodicals related to municipal wastewater treatment.
6. Maintain accurate and neat system operational and maintenance records.
7. Use sound judgment in the expenditure of operating funds.
8. Keep management advised of potential major problems in operation and maintenance of the system.
9. Assist supervisors in preparing an adequate budget.
10. Be aware of safety hazards connected with wastewater treatment.
11. Be prepared to discuss plant operation with plant visitors.
12. Know expected efficiencies of all unit operations and processes in the treatment system and how to monitor these units.

The following is a suggested list of management's responsibilities:

1. Maintain efficient plant operation and maintenance.
2. Maintain adequate treatment system operational and management records.
3. Establish staff requirements, prepare job descriptions, develop organizational charts and assign personnel.
4. Provide operational personnel with sufficient funds to properly operate and maintain the treatment facility.
5. Ensure operational personnel are paid a salary commensurate with their level of responsibility.
6. Provide good working conditions, safety equipment and proper tools for the operational personnel.
7. Establish a harmonious relationship with operational personnel.
8. Provide operational personnel with job security and career ladder.
9. Establish operator training program.
10. Provide incentives for employees.
11. Motivate personnel to achieve maximum efficiency of operation.
12. Make employees aware of importance of proper plant performance.
13. Make periodic inspections of the treatment system to discuss mutual problems with the operational personnel and to observe operational practices.
14. Create an atmosphere that will make operational personnel feel that they can bring special problems to management's attention.
15. Maintain good public relations.
16. Prepare budgets and reports.
17. Plan for future facility needs.

## TYPE OF TREATMENT AND TREATMENT REQUIREMENTS/EFFLUENT LIMITATIONS

In this section of the O & M Manual the type of treatment should be stated in general terms (primary, secondary-trickling filter, secondary-activated sludge, other). The removal efficiencies and/or discharge concentrations of significant parameters that the facility has been designed to produce should be given. These parameters could include:

1. Biochemical Oxygen Demand (BOD).
2. Suspended Solids Concentration
3. pH
4. Other

The design flow, concentrations of significant parameters in the influent, peak hydraulic flow, discharge permit/certificate requirements as they apply to treatment efficiencies or effluent standards (yearly average or monthly average) should be included.

Example:

> The City "A" sewage treatment plant is an activated sludge type secondary treatment plant. It is designed for 85% removal of raw BOD and suspended solids at a concentration of 200 mg/l respectively in the influent, and at a daily average flow of 5 MGD (18,925 cu m/day). Peak hydraulic capacity of the plant is 12.5 MGD (47,313 cu m/day) with any single unit out of service.
>
> The plant design is intended to satisfy the discharge certificate which requires a monthly average of the daily average effluent BODs and suspended solids not to exceed a concentration of 30 mg/l respectively.

## DESCRIPTION OF PLANT TYPE AND FLOW PATTERN

The description of the plant type should be of an introductory nature. Detailed descriptions of unit operations and processes are found in the description, operation and control sections of the manual. Detailed design criteria should be tabulated in the manual's appendix. This introductory description should be presented in a clear and logical manner. A suggested format for this section would be to categorize the treatment system:

- Collection system
- Pretreatment
- Primary treatment
- Secondary treatment
- Advanced treatment
- Disinfection
- Sludge handling

All units within each category should be described briefly. This introductory description of plant type should be limited to one or two pages in the O & M Manual.

A flow pattern should be provided in this section and should complement the plant description given previously. The flow pattern is of an introductory nature and is not intended to illustrate all possible alternate flow paths in the system. Detailed flow diagrams and hydraulic profile should be provided in the engineering drawings of the facility. Figure No. 1 is a sample flow pattern of the type suggested for this section of the manual.

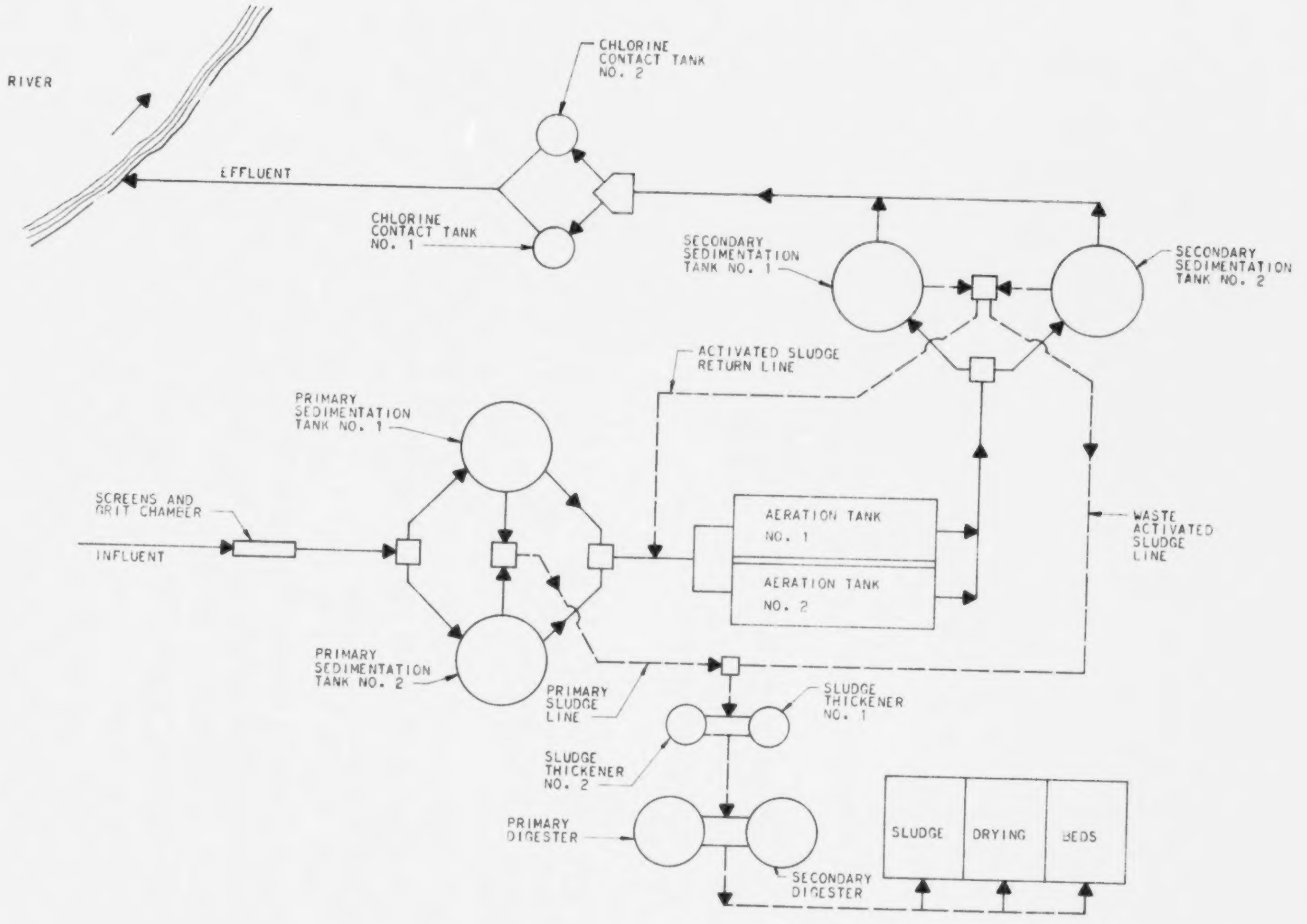
RIVER
EFFLUENT
CHLORINE CONTACT TANK NO. 2
CHLORINE CONTACT TANK NO. 1
SECONDARY SEDIMENTATION TANK NO. 1
SECONDARY SEDIMENTATION TANK NO. 2
ACTIVATED SLUDGE RETURN LINE
PRIMARY SEDIMENTATION TANK NO. 1
SCREENS AND GRIT CHAMBER
INFLUENT
AERATION TANK NO. 1
AERATION TANK NO. 2
WASTE ACTIVATED SLUDGE LINE
PRIMARY SEDIMENTATION TANK NO. 2
PRIMARY SLUDGE LINE
SLUDGE THICKENER NO. 1
SLUDGE THICKENER NO. 2
PRIMARY DIGESTER
SECONDARY DIGESTER
SLUDGE
DRYING
BEDS

FIGURE NO. 1 BASIC FLOW DIAGRAM

A well presented plant description and flow pattern will help generate interest in total plant operation among persons using the manual. If the information is presented in a clear and logical manner, the section can also be used as a guide when explaining the treatment system to plant visitors.

# SECTION VIII

## O & M MANUAL CHAPTER II: PERMITS AND STANDARDS*

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* The format suggested for the table of contents page for the Permits and Standards Chapter of an O & M Manual is identical to the format given for this section of the Considerations Manual.

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## DISCHARGE PERMIT NUMBER AND PERMIT REQUIREMENTS

Sometimes persons in responsible positions within a treatment system are not aware that their facility is operating under a Federal and/or State Discharge Permit. The facility's O & M Manual is a convenient and practical location to maintain a copy of this permit. A discussion of the permit requirements should be included. If operating personnel are aware of permit requirements it can reduce the chances of permit violations occurring as a result of an operator not realizing the consequences of his actions.

The O & M Manual should give the number of the Federal and/or State Discharge Permit for the particular treatment system. The permit requirement should be listed. These requirements include but are not limited to the following:

1. The manner, nature, volume and frequency of the discharge permitted.
2. Procedures for and frequency of any industrial waste monitoring.
3. Proper operation and maintenance of the system by qualified personnel.
4. Any additional condition or restrictions specified by the Regulatory Agencies and/or Permitting Authority.
5. Time period for which permit is valid (expiration date).

A copy of the permit and Federal/State laws or agency regulations dealing with municipal wastewater discharge permits should be included in the manual's appendix or bound separately and properly referenced in this section.

## REPORTING PROCEDURES FOR SPILLS OF RAW OR INADEQUATELY TREATED WASTEWATER

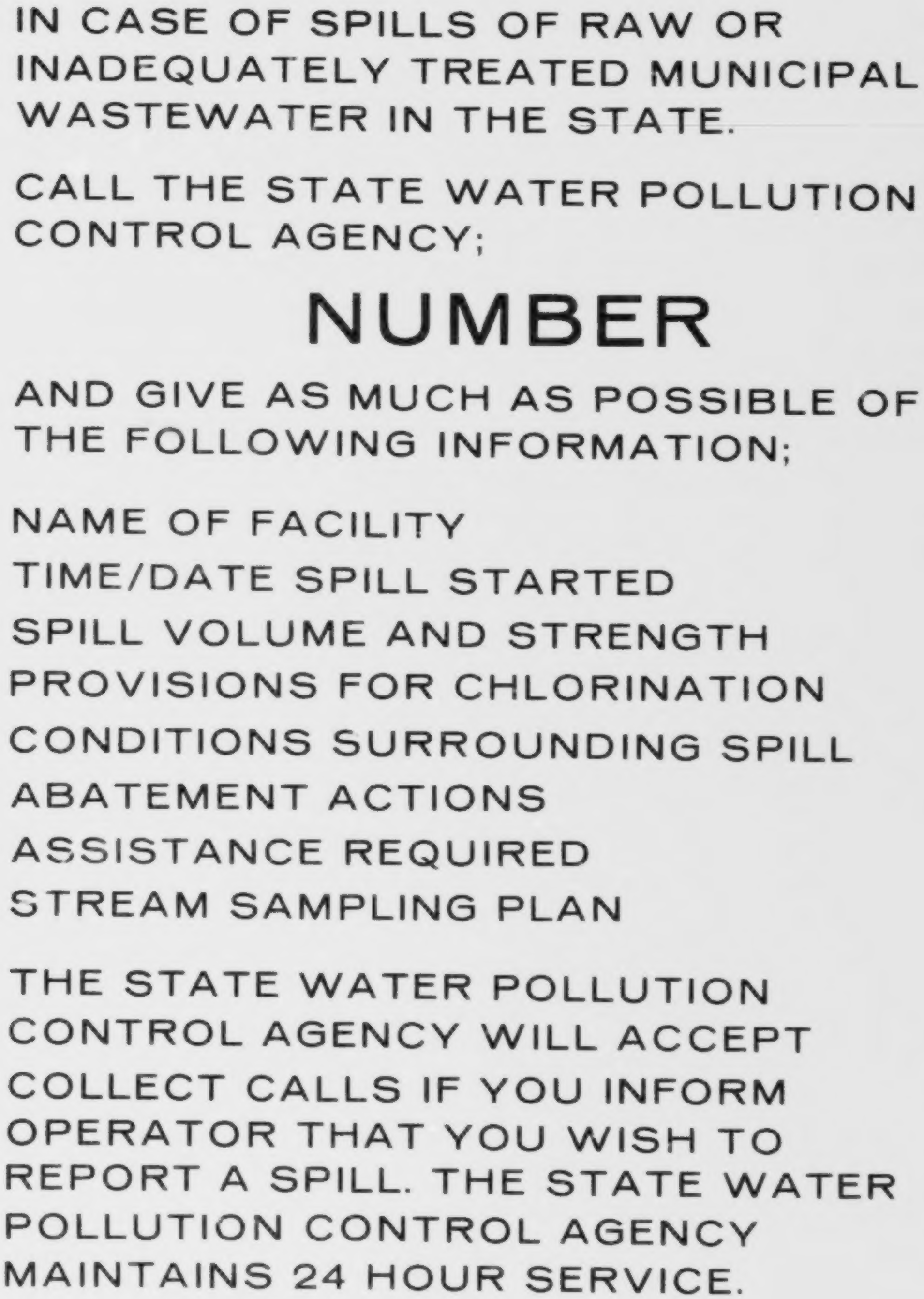
The importance of having treatment system personnel at all levels informed of the reporting procedures for spills of raw or inadequately treated wastewater cannot be overemphasized. Prompt reporting ensures spill clean-up and monitoring assistance can be dispatched to help minimize health hazards and environmental damage. Penalties for being negligent in reporting these conditions are also generally severe and the damage done to public relations can be disastrous to any treatment system.

Included in this section of the O & M Manual should be a discussion of the Federal/State laws and/or agency regulations requiring reporting of a bypass/spill condition. The owner's responsibilities and liabilities should be clearly outlined and penalties for violations should be discussed.

Reporting requirements and procedures should be outlined. Telephone numbers for immediate reporting should be listed. Sample reporting forms should be provided and instructions for completing them given. Responsibilities for this reporting should be clearly established for all treatment system personnel.

Persons preparing this portion of an O & M Manual should be aware that Federal Guidelines on reporting procedures are subject to revision. All information included in this section should be based on current laws and regulations.

A sample wall poster to assist operational personnel in reporting any emergency is shown in Figure No. 2 (similar to poster used by the State of Wisconsin).



IN CASE OF SPILLS OF RAW OR INADEQUATELY TREATED MUNICIPAL WASTEWATER IN THE STATE.

CALL THE STATE WATER POLLUTION CONTROL AGENCY;

**NUMBER**

AND GIVE AS MUCH AS POSSIBLE OF THE FOLLOWING INFORMATION;

NAME OF FACILITY
TIME/DATE SPILL STARTED
SPILL VOLUME AND STRENGTH
PROVISIONS FOR CHLORINATION
CONDITIONS SURROUNDING SPILL
ABATEMENT ACTIONS
ASSISTANCE REQUIRED
STREAM SAMPLING PLAN

THE STATE WATER POLLUTION CONTROL AGENCY WILL ACCEPT COLLECT CALLS IF YOU INFORM OPERATOR THAT YOU WISH TO REPORT A SPILL. THE STATE WATER POLLUTION CONTROL AGENCY MAINTAINS 24 HOUR SERVICE.

FIGURE NO. 2 SAMPLE WALL POSTER
(SIMILAR TO POSTER USED BY STATE OF WISCONSIN)

## WATER QUALITY STANDARDS

Treatment system personnel are often not aware that a classification exists for the body of water receiving their facility's treated effluent. An awareness of the intended use of the receiving stream will help these personnel realize the importance of maintaining a high performance level at their facility. Being able to relate their receiving stream's classification to the State's overall classification system will help these personnel appreciate their role in enhancing the quality of the State's waters.

Copies of the water quality standards for the receiving stream should be provided in this section of the O & M Manual and properly referenced to an appended or separately bound copy of the State's Stream Classification System.

Proper forms and guidelines for permit applications and copies of water quality standards are generally available from one or more of the following sources:

1. State Water Pollution Control Agency
2. State Health Department
3. State Department of Water Resources
4. Environmental Protection Agency Regional Office

# SECTION IX

## O & M MANUAL CHAPTER III: DESCRIPTION, OPERATION AND CONTROL OF WASTEWATER TREATMENT FACILITIES

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## DISCUSSION

The Description, Operation and Control Chapter of an O & M Manual must be considered a key element in any good manual. It is here that operating personnel find detailed descriptions of the unit operations and processes within their systems. Guidance on operating and controlling the treatment plant is outlined in this chapter. This chapter will be consulted when an emergency condition exists. New personnel will study this chapter to learn about the treatment system. Decisions made during plant start-up or when down units are returned to service will be based on the information presented in this chapter. The flexibility designed into the treatment system is outlined here and could prove invaluable in correcting problems arising within the system. It is essential that persons preparing O & M Manuals recognize the importance of this chapter.

The purpose of this chapter is to assist the reader in understanding the construction drawings, the purpose and functions of the treatment plant, and to state the engineer's concept of operation and control of the wastewater treatment processes.

The writer should present a detailed description of the operation, control, and relationship to other plant units of each wastewater treatment process and component, in the order of wastewater flow through the plant, i.e., plant influent system, pretreatment area (screens, grit facilities, comminutors), wastewater flow meter, raw wastewater pumps, primary treatment process (splitter box, primary clarifiers), secondary treatment process (mixing box, trickling filters, recirculation pumps, final clarifiers) (mixing box, aeration tanks, aerators, return activated sludge pumps, final clarifiers), disinfection system (mixing box, contact tanks, disinfection equipment), outfall sewer, effluent water system (pumps, froth control water, cooling water, wash water. chlorine injector water), and City water system (potable water, service water). Included should be photographs and/or schematic diagrams to supplement the verbal descriptions of routine, alternate and emergency operation. The writer should include in his process discussions applicable manual, automatic, physical, chemical, analytical, biological, and laboratory control measures. Discussions concerning applicable safety features, failsafe features, operating problems, causes, and suggested cures, and start-up guidance should also be included.

Suitable references for further study by plant operators should be provided with appropriate consideration given to the complexity of the treatment units/processes and the expertise of the plant personnel.

SAMPLE FORMAT: Table of Contents - O & M Manual Chapter III: Description Operation and Control of Wastewater Treatment Facilities

DESCRIPTION, OPERATION AND CONTROL OF
WASTEWATER TREATMENT FACILITIES

PAGE

PLANT INFLUENT SYSTEM . . . . . . . . . . . . . . . . . . . . . . .
PRETREATMENT FACILITIES . . . . . . . . . . . . . . . . . . . . . .
RAW WASTEWATER METERING . . . . . . . . . . . . . . . . . . . . . .
RAW WASTEWATER PUMPING . . . . . . . . . . . . . . . . . . . . . .
PRIMARY TREATMENT PROCESS . . . . . . . . . . . . . . . . . . . . .
SECONDARY TREATMENT PROCESS . . . . . . . . . . . . . . . . . . . .
ADVANCED WASTEWATER TREATMENT PROCESS . . . . . . . . . . . . . . .
DISINFECTION SYSTEM . . . . . . . . . . . . . . . . . . . . . . . .
PLANT EFFLUENT SYSTEM . . . . . . . . . . . . . . . . . . . . . . .
MUNICIPAL WATER SYSTEM . . . . . . . . . . . . . . . . . . . . . .

The sample format given above is for this chapter's table of contents page in an O & M Manual. Several treatment units may be grouped under a single major heading. For example, under Pretreatment Facilities, the following units should be discussed:

Pretreatment Facilities

1. Grit Collecting

2. Pre-aeration

3. Screening

4. Comminution

Format for Individual Treatment Units and Processes

The sample format given below can be applied to any wastewater treatment unit or process. It can also be applied to any sludge handling unit or process. The format is intended for use with individual treatment units and processes and not for an entire treatment facility.

This format is intended to be flexible. The person preparing this chapter of the O & M Manual should use this sample format as a guide to help ensure all units and processes are adequately described, their operation is discussed and methods for controlling them are outlined.

UNIT OPERATION OR UNIT PROCESS NAME

PAGE

GENERAL

- UNIT/PROCESS DESCRIPTION . . . . . . . . . . . . . . . . . .
- RELATIONSHIP TO ADJACENT UNITS . . . . . . . . . . . . . .
- CLASSIFICATION AND CONTROL . . . . . . . . . . . . . . . .
- MAJOR COMPONENTS . . . . . . . . . . . . . . . . . . . . .
- COMMON OPERATING PROBLEMS . . . . . . . . . . . . . . . .
- LABORATORY CONTROLS . . . . . . . . . . . . . . . . . . .
- START-UP . . . . . . . . . . . . . . . . . . . . . . . . .

SPECIFIC PLANT OPERATION

- NORMAL OPERATION . . . . . . . . . . . . . . . . . . . . .
- ALTERNATE OPERATION . . . . . . . . . . . . . . . . . . .
- EMERGENCY OPERATIONS AND FAILSAFE FEATURES . . . . . . .

Certain components within the wastewater treatment system do not lend themselves to description using the above format. Such treatment related components as prechlorination provided in the plant influent system, raw wastewater metering and pumping, foam control water in the plant effluent system and the municipal water system are in this category. Persons preparing an O & M Manual should give these treatment related components the same attention that is required for treatment units and processes such as primary sedimentation, activated sludge, disinfection and others.

## Examples - Introduction

The following examples are included for illustrative purposes to serve as a guide for the preparation of secondary treatment process sections and as a format guide for the preparation of other wastewater treatment process sections. It should be noted that the examples are divided into two major divisions: a general division containing information generally applicable to all similar treatment processes, and a specific division containing operating information pertinent to the specific plant in question. Although it was outside of the scope of the Considerations Manual to prepare "canned" inserts, the utilization of this format will allow the editing and insertion of "canned" general divisions or at least the reuse in future manuals of general divisions already prepared.

### EXAMPLE

| TRICKLING FILTER | ACTIVATED SLUDGE |
|---|---|
| I. General | I. General |
| A. Process Description | A. Process Description |
| 1. Basic principles - biological slime | 1. Basic Principles - biological floc |
| 2. Operational features | 2. Operational features |
| a. Media bed | a. Mixed liquor suspended solids (MLSS) |

## EXAMPLE

### TRICKLING FILTER (Continued)

- b. Final settling
- c. Recirculation
- 3. Design Efficiency

B. Relationship to adjacent units
- 1. Primary treatment
- 2. Disinfection

C. Classification and control
- 1. Classification - high rate
- 2. Control - recirculation rate

D. Major Components
- 1. Trickling filters
  - a. Distributor
  - b. Media
  - c. Underdrain system
  - d. Vents
- 2. Final clarifiers
  - a. Influent structure and baffle
  - b. Scum baffle, skimmer and trough

### ACTIVATED SLUDGE (Continued)

- b. Oxygen supply
- c. Final settling
- d. Sludge recirculation
- 3. Design efficiency

B. Relationship to adjacent units
- 1. Primary treatment
- 2. Disinfection
- 3. Sludge thickening

C. Classification and control
- 1. Classification - conventional
- 2. Control
  - a. Oxygen supply
  - b. Mixed liquor suspended solids (MLSS)
    - (1) Return sludge rate
    - (2) Sludge wasting
  - c. Hydraulic control

D. Major Components
- 1. Aeration tanks
- 2. Aeration equipment
- 3. Final clarifiers
  - a. Influent structure and baffle
  - b. Scum baffle, skimmer, and trough
  - c. Sludge removal and recirculation
  - d. Effluent weir
- 4. Return sludge pumps

EXAMPLE

TRICKLING FILTER (Continued)

   - c. Sludge removal and recirculation
   - d. Effluent weir
- 3. Recirculation Pumps
   - a. Pumps
   - b. Pump vaults
   - c. Piping

E. Common Operating Problems

- 1. Ponding
- 2. Odors
- 3. Psychoda flies
- 4. Icing of filter surfaces
- 5. Nozzle clogging
- 6. Clogged vent pipes
- 7. Clogged underdrain
- 8. Recirculation pumps
   - a. Will not start
   - b. Reduced rate of discharge
   - c. High power requirements
   - d. Excess noise
   - e. Intermittent feed
   - f. Other
- 9. Final clarifiers
   - a. Floating sludge
   - b. Weirs fouling
   - c. Broken sludge collection mechanism
   - d. Larva

ACTIVATED SLUDGE (Continued)

   - a. Pumps
   - b. Piping
- 5. Waste sludge pumps and sludge thickening (see Chapter on Sludge Handling Facilities)
- 6. Metering

E. Common Operating Problems

- 1. Sludge bulking
- 2. Rising sludge
- 3. Frothing
- 4. Shock loads
- 5. Diffuser clogging
- 6. Surface aerator motor
   - a. Fails to start
   - b. Fails to operate at rated speed
   - c. Runs hot
   - d. Excess vibration and/or noise
- 7. Recirculation pumps
   - a. Will not start
   - b. Reduced rate of discharge
   - c. High power requirements
   - d. Excess noise
   - e. Other
- 8. Final clarifiers
   - a. Floating sludge
   - b. Weirs fouling

## EXAMPLE

### TRICKLING FILTER (Continued)

F. Laboratory Controls
    1. Biochemical oxygen demand (BOD)
    2. Suspended solids
    3. Total solids
    4. Dissolved oxygen
    5. pH
    6. Ammonia, nitrate, nitrite and total organic nitrogen

G. Start-up
    1. Equipment adjustments
    2. Start-up procedures
    3. Controlling start-up

II. Specific Plant Operation

A. Normal Operation
    1. General - schematics
    2. Trickling filters
    3. Final clarifiers
    4. Sludge removal and recirculation
    5. Recirculation pump station

B. Alternate Operation
    1. General description of alternate modes of operation

### ACTIVATED SLUDGE (Continued)

c. Broken sludge collection mechanism

d. Solids carryover

F. Laboratory Controls
    1. Suspended solids
    2. Dissolved oxygen
    3. Volatile suspended solids
    4. Settleable solids
    5. Turbidity
    6. Biochemical oxygen demand (BOD)
    7. Chemical oxygen demand (COD)
    8. Microscopic examination

G. Start-up
    1. Equipment adjustments
    2. Start-up procedures
    3. Controlling start-up

II. Specific Plant Operation

A. Normal Operation
    1. General - schematics
    2. Aeration tanks
    3. Final clarifiers
    4. Return sludge pumps
    5. Sludge wasting (MLSS)

B. Alternate Operation
    1. General description of alternate modes of operation

## EXAMPLE

### TRICKLING FILTER (Continued)

2. Table of valve and gate positions for alternate operating conditions
3. References to construction drawings, shop drawings and construction specifications

C. Emergency Operations and Failsafe Features

1. Warning devices
2. Standby power
3. Hydraulic design
4. Sludge collector mechanism overload alarm
5. Other

### ACTIVATED SLUDGE (Continued)

2. Table of valve and gate positions for alternate operating conditions.
3. References to construction drawings, shop drawings and construction specifications.

C. Emergency Operations and Failsafe Features

1. Warning devices
2. Standby power
3. Hydraulic design
4. Sludge collector mechanism overload alarm
5. Surface aerator thermal overload device.
6. Other

## GENERAL

### UNIT/PROCESS DESCRIPTION

If persons using an O & M Manual are to understand the overall objectives of a treatment plant, they must be provided with descriptions of the major wastewater treatment units and processes in the plant. The descriptions should be brief with appropriate references to more detailed discussions of the unit or process. The description should physically trace the wastewater flow through the treatment unit or process and contain information on design efficiency.

References for persons preparing O & M Manuals:

EPA Manual Entitled: Procedures for Evaluating Performance of Wastewater Treatment Plants*, Contract No. 68-01-0107, Appendices C through G.

Operation of Wastewater Treatment Plants*, a Field Study Training Program, Sacramento State College, for EPA Technical Training Grant No. 5TT1-WP-16-03, Chapters 4 through 10.

WPCF MOP No. 11, Operation of Wastewater Treatment Plants, Chapters 3 through 17.

*NOTE: Both of these references list other sources of additional information.

### RELATIONSHIP TO ADJACENT UNITS

Very few major treatment units or processes operate independently in a municipal wastewater plant. Each unit or process is usually preceded by or followed by units that contribute significantly to overall treatment objectives. Persons using an O & M Manual should be made aware of the role played by units adjacent to the unit or process under consideration. The discussion of the relationships of these adjacent units should include their type and function as they relate to the unit or process being considered. It is also important that a discussion be provided on the point of introduction, the source, nature and effects of extraneous flows. (Supernatant, centrate, filtrate, scrubber waste, etc.)

References for persons preparing O & M Manuals:

WPCF MOP NO. 8, Sewage Treatment Plant Design, Chapters 3 through 16.

Manual of Wastewater Operations, Texas Water Utilities Association, Chapters 7, 9, 11 through 16, and 21.

CLASSIFICATION AND CONTROL

Classification - Knowing the relationship between the unit or process under consideration and other similar units or processes will enable persons using an O & M Manual to compare their treatment systems with other similar systems. The relationship description should be brief with appropriate references cited for detailed information on unit or process modifications.

Control - If proper wastewater treatment is to be achieved, operating personnel should understand the methods available for controlling units and processes. The O & M Manual should list and discuss the control techniques available for each major treatment unit and process.

References for persons preparing O & M Manuals:

Metcalf and Eddy, Inc., "Wastewater Engineering, Collection, Treatment and Disposal", 1972, Chapters 8 through 14.

WPCF MOP No. 11, Operation of Wastewater Treatment Plants, Chapters 3 through 6, and 13 through 17.

## MAJOR COMPONENTS

Most wastewater treatment units contain several major mechanical equipment items. Most wastewater treatment processes also contain several major components. The O & M Manual should list these components for each major treatment unit/process in the facility. These listings will provide manual users with a better understanding of how several components combine to achieve the desired results in a treatment unit or process.

References for persons preparing an O & M Manual:

Manual of Instruction for Sewage Treatment Plant Operators, New York State Department of Health, Chapters 4 through 8.

Steel, E. W., "Water Supply and Sewerage", 1960, Chapters 22 through 27.

## COMMON OPERATING PROBLEMS

One of the principal uses for an O & M Manual will be as a reference book to help solve any operating problems that arise. Each major treatment unit/process within the facility should be analyzed and potential operating problems defined. Potential problems that are peculiar to the facility under consideration should be discussed in the O & M Manual. General problems that are adequately described in other sources should be listed and properly referenced.

References* for persons preparing an O & M Manual:

EPA Manual entitled, Procedures For Evaluating Performance of Wastewater Treatment Plants, Contract No. 68-01-0107, Section IV.

WPCF MOP No. 11, Operation of Wastewater Treatment Plants, Chapters 3, 5, 6, 14, 15 and 17.

Ontario Water Resources Commission, Basic Gas Chlorination Manual

*NOTE: Suppliers of wastewater treatment equipment often provide trouble shooting guides with their equipment. These guides can provide valuable information on recognizing and responding to operating problems.

LABORATORY CONTROLS

Operating personnel must understand the relationship between laboratory test results and the proper operation of treatment units and processes. This portion of an O & M Manual should list the laboratory tests that furnish information to evaluate and control the performance of the unit/process under consideration. Expected ranges for the results of these tests should also be given.

References for persons preparing an O & M Manual:

EPA Manual entitled, Estimating Laboratory Needs For Municipal Wastewater Treatment Facilities, Contract No. 68-01-0328

Standard Methods For The Examination of Water and Sewage, 13th Edition, 1971

WPCF Publication No. 18, Simplified Laboratory Procedures For Wastewater Examination

Sawyer, Chemistry For Sanitary Engineers

McKinney, Microbiology For Sanitary Engineers

START-UP

The start-up of a modern municipal wastewater treatment plant is a complex and demanding task. This portion of the O & M Manual should provide operating personnel with the guidance necessary to inspect and adjust all equipment prior to start-up. The manual should outline the steps for placing the treatment unit or process in operation. Information should also be provided on the special monitoring and controlling of the unit/process until treatment objectives are met.

References* for persons preparing an O & M Manual:

EPA Manual entitled, Start-up of Municipal Wastewater Treatment Facilities, Contract No. 68-01-0341.

WPCF MOP No. 11, Operation of Wastewater Treatment Plants, Chapters 15 and 17.

* NOTE: Suppliers of wastewater treatment equipment often provide procedures for placing their equipment into operation.

## SPECIFIC PLANT OPERATION

### NORMAL OPERATION

It is essential that the treatment plant designer relay to the operating personnel how he intends for the treatment units/processes to operate. This portion of the manual should discuss the normal operation of each wastewater treatment unit and process. Information presented in this section should describe valve and gate positions, wastewater loadings on units, pump settings, speeds of rotating mechanical equipment, and process control variables where applicable. Schematics in the O & M Manual or proper referencing to engineering drawings should be used with this discussion on normal operation.

References* for persons preparing an O & M Manual:

WPCF MOP No. 11, Operation of Wastewater Treatment Plants, Chapters 3 through 6 and 14 through 17.

Manual of Wastewater Operations, Texas Water Utilities Association, Chapters 7, 9, 11 through 16 and 21.

*NOTE: The operating instructions furnished by wastewater treatment equipment suppliers describe the normal operation of their equipment and units.

### ALTERNATE OPERATION

The information on the flexibility of treatment units and processes is as important to operating personnel as the guidance on normal operation. This information on alternate modes of operation will help operating personnel respond to problems arising in their treatment systems. This portion of the manual should list and discuss alternate operating conditions for units/processes. Any information in engineering drawings, equipment shop drawings and construction specifications that helps illustrate alternate modes of operation should be referenced in this section.

NOTE: The treatment plant designer should ensure that all the alternate modes of operation for his treatment units/processes are adequately described in the O & M Manual.

## EMERGENCY OPERATIONS AND FAILSAFE FEATURES

Although the O & M Manual should contain an Emergency Operating and Response Program Chapter, the information in that chapter deals primarily with total facility readiness. Treatment plant operating personnel should also be made aware of procedures to follow when isolated equipment items or treatment units require emergency operations. In connection with these emergency operations, information on failsafe features such as no bypass, peak flow capacities, standby power and overload alarms should be made available to operating personnel. This section of the O & M Manual should list and discuss the emergency operating procedures and failsafe features for each wastewater treatment unit and process.

References* for persons preparing an O & M Manual:

EPA Manual entitled, Emergency Operating Procedures For Municipal Wastewater Facilities, Contract No. 68-01-0341.

EPA Manual entitled, Procedures For Evaluating Performance of Wastewater Treatment Plants, Contract No. 68-01-0107, Section IV.

*NOTE: The treatment plant designer should ensure that all failsafe features in his treatment units/processes are adequately described in the O & M Manual.

# SECTION X

## O & M MANUAL CHAPTER IV: DESCRIPTION, OPERATION AND CONTROL OF SLUDGE HANDLING FACILITIES

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DISCUSSION

In the field of municipal wastewater treatment, the facilities for handling sludge are becoming quite sophisticated. Some existing O & M Manuals devote over half of their contents to the treatment system's sludge handling facilities. Because of its importance and because the processes involved can be readily separated from the treatment of the liquid fraction of the raw wastewater, a separate chapter of the O & M Manual should address the sludge handling facilities. The preparation of this chapter should be given the same care as the wastewater treatment facilities chapter. Operating personnel will consult this sludge handling section for the same purposes as those outlined under the wastewater treatment chapter.

The purpose of this chapter is to assist the reader in understanding the purpose, functions, operation and control of the sludge handling facilities.

The writer should give a detailed description of the operation, control, and relationship to other plant units of each sludge handling component and unit, i.e., sludge thickeners, pumping stations, digesters, drying beds, conditioning, gas control and use, incineration, dewatering, ultimate disposal, and other items. Include photographs and/or schematic diagrams to supplement the verbal descriptions of routine, alternate and emergency operation. Included should be applicable manual, automatic, physical, chemical, analytical, biological, and laboratory control measures. The applicable safety and failsafe features should be discussed including any encountered operating problem, causes, and suggested cures. Start-up guidance also should be included.

Suitable references for further study by plant operators should be provided with appropriate consideration given to the complexity of the treatment units/processes and the expertise of the plant personnel.

SAMPLE FORMAT: Table of Contents - O & M Manual Chapter IV: Description, Operation and Control of Sludge Handling Facilities

PAGE
SLUDGE PUMPING . . . . . . . . . . . . . . . . . . . . . . . . .
CONCENTRATION . . . . . . . . . . . . . . . . . . . . . . . . . .
DIGESTION . . . . . . . . . . . . . . . . . . . . . . . . . . . .
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INCINERATION/HEAT TREATMENT OR WET OXIDATION . . . . . . . . . . .
ULTIMATE DISPOSAL . . . . . . . . . . . . . . . . . . . . . . . .

The sample format given above is for this chapter's table of contents page in an O & M Manual. The format is intended to be flexible and few treatment systems will have units in all the headings listed.

## Format for Individual Unit Operations and Processes

The sample format for individual treatment units and processes presented in Section IX, Description, Operation and Control of Wastewater Treatment Facilities can be used for all sludge handling units and processes.

## Example - Introduction

The purpose of this example is similar to that outlined under the introduction for the trickling filter and activated sludge process examples in Section IX, Description, Operation and Control of Wastewater Treatment Facilities. This example can serve as a guide in the preparation of this chapter of an O & M Manual.

NOTE: Certain components used in sludge handling do not lend themselves to description using the format mentioned above. Such sludge handling related components as sludge pumping and ultimate sludge disposal techniques are in this category. Persons preparing an O & M Manual should give these sludge handling components the same attention that is required for major sludge handling units and processes such as thickeners, digestion, and vacuum filters.

## EXAMPLE
## GRAVITY SLUDGE THICKENER

I. General

- A. Unit Description
  - 1. Basic principles
    - a. Hydraulic surface loading
    - b. Solids loading
  - 2. Operational features
    - a. Circular tank
    - b. Sludge collection and transfer mechanism
  - 3. Design efficiency

- B. Relationship to Adjacent Units
  - 1. Aeration tanks
  - 2. Clarifiers
  - 3. Digesters

- C. Classification and Control
  - 1. Classification - Activated sludge thickener
  - 2. Control
    - a. Sludge volume ratio (SVR)
    - b. Sludge density

- D. Major components
  - 1. Thickener tank
  - 2. Sludge collection mechanism
  - 3. Sludge pumps
  - 4. Dilution water pumps

EXAMPLE

GRAVITY SLUDGE THICKENER

(Continued)

E. Common Operating Problems
   1. Floating sludge
   2. Broken sludge collection mechanism
   3. Sludge pumps
      a. Pump will not start
      b. Reduced rate of discharge
      c. High power requirements
      d. Excess noise
      e. Other
   4. Odors

F. Laboratory Controls
   1. Solids loading
   2. Dissolved oxygen
   3. Hydraulic loading

G. Start-up
   1. Equipment inspection
   2. Start-up procedures
   3. Controlling start-up

II. Specific Plant Operation

A. Normal Operation
   1. General - Schematics
   2. Sludge collection and transfer mechanism

## EXAMPLE
## GRAVITY SLUDGE THICKENER
## (Continued)

B. Alternate Operation
   1. General description of alternate operation modes
   2. Table of valve and gate positions for alternate operating conditions
   3. References to construction drawings, equipment shop drawings and construction specifications

C. Emergency Operations and Failsafe Features
   1. Warning devices
   2. Standby power
   3. Hydraulic design
   4. Sludge collector mechanism overload alarm
   5. Pump capacities
   6. Piping configuration

## SLUDGE HANDLING
## GENERAL

### UNIT/PROCESS DESCRIPTION

As municipal wastewater sludge handling facilities become more sophisticated, it is essential that O & M Manual users be provided with adequate descriptions of the major sludge handling units and processes in the plant. The descriptions should be brief, physically trace the sludge through the unit or process, and contain information on design performance.

References* for persons preparing O & M Manuals:

FWPCA, A Study of Sludge Handling and Disposal, Grant No. PH-86-66-32, Publication WP-20-4, May 1968.

WPCF MOP No. 20, Sludge Dewatering, 1969.

Operation of Wastewater Treatment Plants**, a Field Study Training Program, Sacramento State College, for EPA Technical Training, Grant No. 5TT1-WP-16-03, Chapter 8.

WPCF MOP No. 11, Operation of Wastewater Treatment Plants, Chapters 7 through 12.

*NOTE: Manufacturers of sludge handling equipment such as vacuum filters, centrifuges, and incinerators generally provide acceptable descriptions for their units.

**NOTE: This reference lists other sources of additional information.

### RELATIONSHIP TO ADJACENT UNITS

Most sludge handling units and processes are usually preceded by and/or followed by units that contribute significantly to the plant's overall sludge handling objectives. For a complete understanding of any given sludge handling unit/process, O & M Manual users should understand the function of units adjacent to the unit/process under consideration. The discussion of the relationships of these adjacent units should include their type and function.

References for persons preparing O & M Manuals:

Metcalf & Eddy, Inc. "Wastewater Engineering Collection Treatment and Disposal", 1972, Chapters 8, 11 and 13.

EPA Manual entitled, Procedures For Evaluating Performance of Wastewater Treatment Plants*, Contract No. 68-01-0107, Appendix F.

*NOTE: This reference lists other sources of additional information.

CLASSIFICATION AND CONTROL

Classification - O & M Manual users should benefit from a comparison between the sludge handling unit/process under consideration and other similar facilities. This comparison should be brief and references for additional information on these related units/processes should be listed.

Control - The satisfactory performance of most sludge handling units/processes is dependent upon proper operator control. The control techniques available for each major sludge handling unit and process should be listed and each technique discussed in the O & M Manual.

References for persons preparing O & M Manuals:

FWPCA, A Study of Sludge Handling and Disposal, Grant No. PH-86-66-32, Publication WP-20-4, May 1968.

WPCF MOP No. 11, Operation of Wastewater Treatment Plants, Chapters 7 through 12.

MAJOR COMPONENTS

Most municipal sludge handling processes consist of several major components. Even individual sludge handling units usually have several major mechanical equipment items. O & M Manual users should be made aware of the major components that comprise the sludge handling unit/process under consideration. The O & M Manual should list these components for each major sludge handling unit/process in the plant.

References for persons preparing an O & M Manual.

Manual of Wastewater Operations, Texas Water Utilities Association, Chapters 17 through 20.

WPCF MOP No. 8, Sewage Treatment Plant Design, Chapters 13 through 15.

COMMON OPERATING PROBLEMS

After standard operating procedures have been developed and the plant has started-up, the O & M Manual's primary function is that of a tool to help solve operating problems. Potential operating problems for each major sludge handling unit/process should be defined. Problems peculiar to the plant's sludge handling facilities should be discussed in the O & M Manual. General problems, adequately discussed in other sources, should be listed and properly referenced.

References* for persons preparing an O & M Manual:

EPA Manual entitled, Procedures For Evaluating Performance of Wastewater Treatment Plants, Contract No. 68-01-0107, Section IV.

*NOTE: Suppliers of wastewater treatment equipment often provide trouble shooting guides with their equipment. These guides can provide valuable information on recognizing and responding to operating problems.

LABORATORY CONTROLS

Laboratory test results provide information essential to evaluating and controlling sludge handling units/processes. This portion of the O & M Manual should list all required laboratory tests and give expected ranges for the results of these tests.

References for persons preparing an O & M Manual:

Standard Methods For The Examination of Water and Sewage, 13th Edition, 1971.

WPCF Publication No. 18, Simplified Laboratory Procedures For Wastewater Examination

Weber, "Physicochemical Processes For Water Quality Control", Chapter 12.

START-UP

Starting-up the sophisticated sludge handling facilities in a modern municipal treatment plant is a complex task. Operating personnel should be provided with information on inspecting and adjusting mechanical equipment prior to start-up. The personnel should be given instructions on placing units/processes into operation and controlling them until the sludge handling objectives are met. This portion of an O & M Manual should describe the start-up information for the unit/process under consideration.

References* for persons preparing an O & M Manual.

EPA Manual entitled, Start-up of Municipal Wastewater Treatment Facilities, Contract No. 68-01-0341

WPCF MOP No. 16, Anaerobic Sludge Digestion, Chapter 6

*NOTE: Suppliers of wastewater treatment equipment often provide procedures for placing their equipment into operation.

# SLUDGE HANDLING
## SPECIFIC PLANT OPERATION

### NORMAL OPERATION

An important function of any O & M Manual is to provide operating personnel with an understanding of the normal operation of each major sludge handling unit and process. This section of an O & M Manual should describe valve positions, heat requirements, sludge blanket depths, sludge pumping schedules, and other pertinent sludge handling facts. Schematics in the O & M Manual or proper referencing to engineering drawings should be used with this discussion on normal operation.

References* for persons preparing an O & M Manual:

FWPCA, A Study of Sludge Handling and Disposal, Grant No. PH-86-66-32, Publication WP-20-4, May 1968.

WPCF MOP No. 11, Operation of Wastewater Treatment Plants, Chapters 7 through 12.

WPCF MOP No. 20, Sludge Dewatering, 1969

WPCF MOP No. 16, Anaerobic Sludge Digestion, 1968.

*NOTE: The operating instructions furnished by suppliers of sludge handling equipment and units describe the normal operation of these items.

### ALTERNATE OPERATION

The flexibility designed into sludge handling units/processes can best be described by listing alternate modes of operation for each unit and process under consideration. Any information in engineering drawings, equipment shop drawings, and construction specifications that helps illustrate alternate modes of operation should be referenced in this section of an O & M Manual.

NOTE: The treatment plant designer should ensure that all the alternate modes of operation for his treatment units/processes are adequately described in the O & M Manual.

EMERGENCY OPERATIONS AND FAILSAFE FEATURES

Having procedures established for operating sludge handling facilities during emergency conditions can minimize damages to equipment and processes. These procedures can also reduce the chances for injury to operating personnel. This portion of an O & M Manual should list and discuss the emergency operating procedures and failsafe features for each sludge handling unit and process. Failsafe features associated with sludge handling facilities include standby power, overload alarms, explosive gas alarms, etc.

References* for persons preparing an O & M Manual:

EPA Manual entitled, Emergency Operating Procedures for Municipal Wastewater Facilities, Contract No. 68-01-0341.

EPA Manual entitled, Procedures for Evaluating Performance of Wastewater Treatment Plants, Contract No. 68-01-0107, Section IV.

*NOTE: The treatment plant designer should ensure that all failsafe features in his treatment units/processes are adequately described in the O & M Manual.

# SECTION XI

## O & M MANUAL CHAPTER V: PERSONNEL*

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* The format suggested for the table of contents page for the Personnel Chapter of an O & M Manual is similar, except for the general discussion, to the format given for this section of the Considerations Manual.

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## GENERAL

Regardless of the care which goes into the design and construction of a treatment facility, without qualified personnel in adequate numbers to operate the processes, the full capabilities of the facility cannot be realized. A well thought-out staff requirement will assist the treatment system's management as they seek funds for staffing their facility. The manpower requirements recommended should be compatible with existing Federal and State guidelines.

Up-to-date training for operators and maintenance personnel should be stressed as being of critical importance in the proper functioning of the wastewater treatment facility. The purpose is to protect the huge investment in plant equipment from damage or deterioration, and to improve the quality of the effluent.

The purpose of this section of the O & M Manual is to give the manpower requirements for the treatment system. The qualifications of personnel to include training, experience and demonstrated skills are given in this section. Plant operator certification programs should be discussed and job descriptions for all personnel should be given.

## MANPOWER REQUIREMENTS - STAFF

The preparation of this section of a facility's O & M Manual should be closely coordinated with the owners of the treatment system. The need for information on manpower requirements will vary with a facility's ability to determine their own plant staff and training needs.

The Environmental Protection Agency has developed three manuals entitled "Estimating Staffing For Municipal Wastewater Treatment Facilities", Contract No. 68-01-0328, "Estimating Costs and Manpower Requirements for Conventional Wastewater Treatment Facilities", Contract No. 14-12-462, and "Estimating Laboratory Needs For Municipal Wastewater Treatment Facilities", Contract No. 68-01-0328, to provide assistance in estimating facility personnel requirements. The Environmental Protection Agency also is establishing manpower planning and training capabilities in regional, state and local water pollution control agencies to assist in this area. Other ongoing EPA programs include maintaining and disseminating manpower planning criteria in the form of occupation definitions and staffing guides.

To adequately prepare manpower recommendations, a task analysis of each job within the treatment system should be made. This analysis will provide details on the skills and qualifications required for each position.

There are specialized methods and techniques and professionals available for the determination of manpower and training requirements. Persons responsible for O & M Manual preparation should consider using personnel with specialized skills in manpower factors to determine personnel and training needs.

The manpower requirements or staff should be given as a total number with individual areas such as supervision, administration, operation and maintenance broken down.

If minimum staffing requirements have been established by a state regulatory agency for various size treatment facilities the applicable requirement should be cited. Table No. 1 gives a typical breakdown of plant capacity versus minimum operating personnel.

Where certain positions in the treatment system require certification by state law, these should be indicated in this section and discussed in the certification section.

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STATE OF ILLINOIS
ENVIRONMENTAL PROTECTION AGENCY
WPC TECHNICAL POLICY 20-24

REVISED JULY, 1971

TABLE NO. 1

MINIMUM OPERATING PERSONNEL

| PLANT CAPACITY | OPERATOR |
|---|---|
| 0.1 MILLION GAL/DAY (LESS THAN) | MINIMUM OF 2 HOURS OPERATION TIME DAILY |
| 0.1 MILLION GAL/DAY | 1/2 FULL TIME 5 DAYS PER WEEK<br>2 HRS. SAT., SUN. & HOLIDAYS |
| 0.25 MILLION GAL/DAY | 1 FULL TIME - 5 DAYS PER WEEK<br>2 HRS. SAT., SUN. & HOLIDAYS |
| 0.5 MILLION GAL/DAY | 1 FULL TIME OPERATOR<br>1/2 TIME ASSISTANT (FULL TIME FOR ACTIVATED SLUDGE PLANT) |
| 1.0 MILLION GAL/DAY | 2 FULL TIME OPERATORS<br>1 ASSISTANT |
| 5.0 MILLION GAL/DAY | 1 SUPERINTENDENT<br>4 OPERATORS<br>1 MAINTENANCE MAN<br>1 ASSISTANT |
| 10.0 MILLION GAL/DAY | 1 SUPERINTENDENT<br>1 CHEMIST<br>6 OPERATORS<br>1 MAINTENANCE MAN<br>2 ASSISTANTS |

In some municipal wastewater treatment operations, the character of each of the three daily shifts is quite different. An example would be the reduction of the maintenance forces during the 4:00 PM to 8:00 AM shifts. Another example could be a vacuum filter operation that is run intermittently and where manpower requirements drop off when the filter is idle. The personnel chapter of an O & M Manual should discuss the particular shift staffing requirements for the facility at hand.

QUALIFICATIONS

The qualifications for all types of personnel should be listed. Personnel types include superintendent, operators, maintenance men, chemists and assistants for all levels. Job descriptions for all personnel should be given. This description might include the following for an operator: Follow shift standard procedures, keep daily operating records, check all meters and recorders for proper operation and check and adjust chlorinators for proper operation, chlorine used, and chlorine residual.

The following is a list of the types of personnel commonly employed for operation and maintenance of conventional wastewater treatment systems:

Occupation Description*

1. Superintendent
2. Assistant Superintendent
3. Clerk-Typist
4. Operations Supervisor
5. Shift Foreman
6. Operator II
7. Operator I
8. Automotive Equipment Operator
9. Maintenance Supervisor
10. Mechanical Maintenance Foreman
11. Maintenance Mechanic II
12. Maintenance Mechanic I
13. Electrician II
14. Electrician I
15. Maintenance Helper
16. Laborer
17. Painter
18. Storekeeper
19. Custodian
20. Chemist
21. Laboratory Technician

*Report for EPA, "Estimating Costs and Manpower Requirements for Conventional Wastewater Treatment Facilities", Contract No. 14-12-462.

The following outline for presenting an occupation description is taken from a report prepared for EPA entitled, "Estimating Costs and Manpower Requirements for Conventional Wastewater Treatment Facilities", Contract No. 14-12-462.

Title: (Give title of position)

Job Description
Qualifications Profile

1. Formal education
2. General requirements
3. General educational development
    a. Reasoning
    b. Mathematical
    c. Language
4. Special vocational preparation
5. Aptitudes - Relative to general working conditions
    a. Intelligence
    b. Verbal
    c. Numerical
    d. Form perception
    e. Spatial
    f. Clerical perception
    g. Motor coordination
    h. Finger dexterity
    i. Manual dexterity
    j. Eye-hand-foot coordination
    k. Color discrimination
6. Interests
7. Temperament
8. Physical demands
9. Working conditions

Complete and accurate job descriptions are sometimes difficult to prepare. The effort required to develop these job descriptions should not be underestimated. Good job descriptions should include but are not limited to the following:

1. List items or processes that individual must operate.
2. State if monitoring of gages or meters is required.
3. Discuss interpreting of any meter or gage readings for process control actions.
4. List any logs or records to be maintained.
5. Outline any maintenance duties required.
6. State any other title that individual might carry.
7. Discuss decision making requirements.
8. State responsibilities and authority given to individual in job being described.
9. List any report or budget functions that must be performed.
10. Discuss any supervisory or inspection functions.

Any training requirements for treatment system personnel should be outlined in this section.

Any state and federal training programs available at or near the treatment plant should be listed in this section.

CERTIFICATION

The pertinent details of any existing State Certification Program should be discussed with emphasis on how they apply to the treatment system at hand. This discussion should include a copy of the rules and regulations of the State Certification Board. This copy may be appended or bound separately if properly referenced in this section of the manual.

NOTE:

A Model State Act for mandatory certification of operators of water treatment plants, water distribution systems, and wastewater facilities has been adopted by the Council of State Governments and can be found in the Journal Water Pollution Control Federation Vol. 44, p. 1884 (October 1972). This Model State Act will be of interest to individuals not familiar with operator certification.

# SECTION XII

## O & M MANUAL CHAPTER VI: LABORATORY TESTING*

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* The format suggested for the table of contents page for the Laboratory Testing Chapter of an O & M Manual is similar, except for the Discussion portion, to the format given for this section of the Considerations Manual.

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DISCUSSION

The treatment system laboratory testing program provides the basis for process control and produces a record of how the treatment facilities are operating. This information keeps the operating personnel informed of plant efficiencies and helps in predicting problems that are developing in the system. Because laboratory test results are a record of plant performance, they are often evaluated by governing and/or regulatory bodies. For these reasons, it is essential a treatment system's laboratory testing program produce complete and accurate results.

This chapter of an O & M Manual should be used to emphasize the necessity and importance of laboratory tests in municipal wastewater treatment. The sampling procedures and frequency for the various laboratory tests should be described. The tests to be performed should be listed and a brief description of their nature and purpose given. The detailed discussion of how each type test can be used in controlling and/or monitoring a specific treatment process should be given in the "Description, Operation and Control" chapters of the manual.

The definitions of grab and composite sampling should be given. A suggested schedule for performing the various laboratory tests should be outlined. A list of reference materials for use in the laboratory should be given. All references considered essential for proper laboratory operation should be provided as a part of the total O & M Manual package. Samples of the laboratory worksheets recommended for use in the lab should be included.

Any information related to required effluent and receiving stream monitoring should be included under the Permits and Standards chapter of the manual. Water Quality Standard information should also be included under the Permits and Standards Chapter.

The EPA Construction Grants Program requires that the grantee ensure, for each grant assisted plant, provisions for adequate laboratory testing in accordance with Section 35.935-12 of the 40 CFR, Part 35.

To provide detailed information on laboratory equipment and staffing, EPA has developed a manual entitled, "Estimating Laboratory Needs For Municipal Wastewater Treatment Facilities", Contract No. 68-01-0328. In mid-1973 EPA also will publish in the Federal Register, Guidelines establishing test procedures for the analysis of pollutants as required by Section 304(g) of the FWPCA Amendments of 1972.

## PURPOSE

This section of the O & M Manual's Laboratory Testing Chapter must relay to treatment facility personnel the importance of complete and accurate laboratory records. It should explain the role of the laboratory in treatment process control, in providing an operating record for the treatment system, and in analyzing problems within a treatment unit/process.

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## SAMPLING PROGRAM

The value of results from wastewater laboratory testing is dependent upon the sample being representative of the source from which it was taken. There are two types of samples taken for wastewater laboratory analyses. Their definitions follow:

> Composite Sample - A combination of individual samples taken at selected time intervals, for some specified period, to minimize the effect of the variability of the individual sample. Samples may be of equal volume or proportional to flow at time of sampling.
>
> Grab Sample - A single sample taken at neither set time nor flow.

The following is a list of general guidelines for sampling municipal wastewater:

1. Samples should be taken at locations where the wastewater is as completely mixed as possible (Specific locations should be given for system at hand).

2. Particles greater than one-quarter inch in diameter should be excluded when sampling.

3. Any floating materials, growths, etc., which may have collected at a sampling location should not be included when sampling.

4. If samples are to be kept for an hour or more prior to testing, they should be immersed in ice water to retard bacterial action.

5. Proper sampling equipment should be provided and safety precautions should be exercised during all sampling.

6. Consideration should be given to the relationship between the plant's daily flow variation and detention time through the units so that influent and effluent samples relate to the same waste.

Figure No. 3 is a sample format for a Laboratory Sampling Program.

This portion of the manual should contain a discussion of potential cross-connection hazards and suggestions for periodic testing for bacteria in the plant's potable water system.

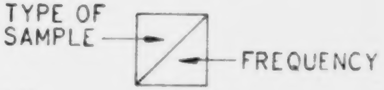
FIGURE NO. 3 SAMPLE LABORATORY TESTING PROGRAM

| | SETTLEABLE SOLIDS | SUSPENDED SOLIDS | BOD | CHLORINE RESIDUAL | GREASE | TOTAL DISSOLVED SOLIDS | COLIFORM ORGANISMS | VOLATILE SUSPENDED SOLIDS | DISSOLVED OXYGEN | TOTAL SOLIDS | TOTAL VOLATILE SOLIDS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RAW SEWAGE | C / D | C / D | C / D | | | C / W | | C / D | | C / W | C / W | | |
| PRIMARY EFFLUENT | C / D | C / D | C / D | | | | | C / D | | C / W | C / W | | |
| SECONDARY EFFLUENT | C / D | C / D | C / D | | C / W | | | C / D | | C / W | C / W | | |
| CHLORINE CONTACT TANK | | | | G / * | | | | | | | | | |
| MIXED LIQUOR | | C / D | | | | | | | | | | | |
| PLANT EFFLUENT | | | C / W | G / $D_2$ | | C / W | G / W | | G / D | | | | |
| | | | | | | | | | | | | | |

LEGEND:

TYPE OF SAMPLE
C - COMPOSITE SAMPLE
G - GRAB SAMPLE
* EVERY 4-HOURS

FREQUENCY
D - DAILY
W - WEEKLY
$D_2$- TWICE DAILY



The EPA Manual entitled, "Procedures for Evaluating Performance of Waste-Water Treatment Plants", Contract No. 68-01-0107 contains a minimum process testing guide. Additional information on sampling programs can be found in the EPA Manual entitled "Estimating Laboratory Needs for Municipal Facilities", Contract No. 68-01-0328.

OPERATOR/LABORATORY REFERENCES*

1. "Standard Methods for Examination of Water and Sewage."
2. EPA publication "Methods for Chemical Analysis of Water and Waste" (GPO Stock No. 5501-0067).
3. WPCF Publication No. 18, "Simplified Laboratory Procedures for Wastewater Examination."
4. WPCF Manual of Practice No. 11, "Operation of Wastewater Treatment Plants."
5. "Manual of Wastewater Operations", Texas Water Utilities Association.
6. "Manual of Instruction for Sewage Treatment Plant Operators", New York State Department of Health.
7. "Chemistry for Sanitary Engineers", Sawyer, McGraw-Hill.

*NOTE: All essential references should be provided as part of the total O & M Manual package.

INTERPRETATION OF LABORATORY TESTS

The detailed discussion of how each test can be used in controlling and/or monitoring a specific treatment process should be given in the "Description, Operation and Control" chapters of the O & M Manual.

The detailed procedures for performing each test do not have to be included in the O & M Manual, but should be properly referenced to one or more of the laboratory reference documents provided.

In this section each laboratory test should be defined and its general applications to municipal wastewater treatment discussed. This discussion should be tailored according to the laboratory staff capabilities of the facility under consideration.

The following are examples of the type information to be provided for various tests under this section.

pH

pH is a term used to express the intensity of the acid or alkaline condition of a solution. The pH scale is usually represented as ranging from 0 to 14, with pH 7 representing absolute neutrality. Acid conditions increase as pH values decrease, and alkaline conditions increase as the pH values increase.

Dissolved Oxygen (DO)

Dissolved Oxygen represents the amount of oxygen in solution (dissolved) in a liquid. The solubility of oxygen in fresh waters ranges from 14.6 mg/l at $0^{\circ}$ C to about 7 mg/l at $35^{\circ}$ C. The solubility of oxygen is at a minimum when temperatures are high. In wastewater testing, dissolved oxygen measurements are used to monitor aerobic conditions in receiving streams and in controlling aerobic treatment processes.

Biochemical Oxygen Demand (BOD)

The BOD test is used to determine the oxygen required to stabilize biologically the organic matter present in the wastewater. It is the principal test to determine the strength, in terms of oxygen required, of municipal wastewater. It is widely used to evaluate the efficiency of various treatment processes and to estimate the effects of pollution on receiving streams. BOD test results are usually reported in milligrams per liter (mg/l) of oxygen consumed at the end of a five day test period. These results are referred to as the 5-day BOD ($BOD_5$) and should not be confused with the ultimate BOD ($BOD_U$) of the sample.

### Settleable Solids

The term "settleable solids" is applied to solids in suspension that will settle, under quiescent conditions, because of the influence of gravity. This test is an indication of the volume of solids removed by sedimentation and test results are measured and reported in terms of milliliters per liter of settleable solids.

### Suspended Solids

The undissolved substances in wastewater are usually referred to as suspended solids. It is a major parameter in evaluating wastewater strength and in determining the efficiency of treatment processes. It is also used to estimate effects of pollution on receiving streams. It is used with activated sludge mixed liquor testing in determining the sludge density index. This index is an important part of activated sludge process control. Suspended solids test results are reported in terms of milligrams per liter.

### Chlorine Residual

Chlorine residual is the chlorine remaining in wastewater at the end of a specified contact period and test results are reported in terms of milligrams per liter. It is used to determine if desired chlorination objectives are being met.

### Volatile Acid

Volatile acids are formed during the anaerobic degradation of carbohydrates, proteins, and fats. The test is valuable in the routine control of anaerobic digestion units. The volatile acid content of digesting sludges usually is in the range of 50 to 250 mg/l, expressed as acetic acid.

### Chemical Oxygen Demand (COD)

The COD test is based on the fact that practically all organic compounds can be oxidized by the action of strong oxidizing agents under acid conditions. During the test, organic matter is converted to carbon dioxide and water regardless of the biological assimilability of the substances. As a result, COD values can be much greater than BOD values if large amounts of biologically resistant organic matter are present. The test is widely used in the operation of industrial treatment facilities because of the speed with which results can be obtained. It is also used to estimate the effects of pollution and receiving streams. COD test results are reported in terms of milligrams of oxygen per liter of sample.

## SAMPLE LABORATORY WORKSHEETS

Samples of the laboratory worksheets recommended for use in the lab should be included. Figure No. 4 is a sample worksheet for solids determinations and Figure No. 5 is a sample worksheet for BOD determinations. A detailed discussion of the laboratory records recommended for use by the treatment system should also be included in this portion of the chapter.

SAMPLE BENCH SHEET FOR SOLIDS DETERMINATION*

Daily Report Sheet Date __________ 19 ___

City __________________ State __________________

| Suspended Solids | Raw | Primary Effluent | Mixed Liquor | Final Effluent |
|---|---|---|---|---|
| Container number | #4 | #5 | Paper 4 | #6 |
| Volume filtered (ml) | 50 | 100 | 100 | 100 |
| Weight of container plus solids (g) | 24.3760 | | 0.3500 | |
| Weight of container (g) | 24.3620 | | .0500 | |
| Difference in mg (A) | 14.0 | | 300.0 | |
| $\frac{1,000}{\text{ml volume filtered}}$ (B) | 20 | | 10 | |
| (A) x (B) | 280 | | 3,000 | |

| Sludge Solids | Raw | Digested |
|---|---|---|
| Dish No. | 9 | |
| Sample volume (ml) | 25 | |
| Weight of dish plus solids (g) | 25.7420 | |
| Weight of dish (g) | 20.0000 | |
| (C) Difference in g | 5.742 | |
| Weight of dish plus dried solids (g) | 20.2871 | |
| Weight of dish (g) | 20.0000 | |
| (D) Difference in g | .2871 | |
| Percent solids = $\frac{D}{C} \times 100$ | 5.0% | |

| Volatile Solids | Raw | Digested |
|---|---|---|
| Dish No. | 9 | |
| Dish (g) + dry solids | 20.2871 | |
| Dish + Ash (g) | 20.2762 | |
| (E) Loss Wt. (g) | 0.2009 | |
| Percent Volatile Solids = $\frac{E}{D} \times 100$ | $\frac{0.2009}{0.2871} \times 100$<br>= 70% | |

FIGURE NO. 4 SAMPLE: SOLIDS DETERMINATION WORKSHEET

*Courtesy of Water Pollution Control Federation, Manual of Practice No. 18, p. 57

SAMPLE BENCH SHEET FOR BOD DETERMINATION*

Daily Report Sheet Date __________ 19 __

City __________ State __________

| BOD Sample | Raw | | | Primary Effluent | | | Final Effluent | Blank Water | Seed Settled Sewage |
|---|---|---|---|---|---|---|---|---|---|
| Bottle no. | 61 | 62 | 63 | 64 | 65 | 66 | | 70 | 73 |
| ml sample in bottle | 3 | 6 | 9 | 6 | 9 | 12 | | 0 | 6 |
| Percent dilution | 1 | 2 | 3 | 2 | 3 | 4 | | | 2 |
| Dilution factor | 100 | 50 | 33.3 | 50 | 33.3 | 25 | | 1 | 50 |
| Before incubation: | | | | | | | | | |
| Buret read. after (ml) | 7.8 | 15.7 | 23.4 | | | | | 8.2 | 8.0 |
| Buret read. before (ml) | 0 | 7.8 | 15.7 | | | | | 0 | 0 |
| (A) Difference, ml of "thio" | 7.8 | 7.9 | 7.7 | | | | | 8.2 | 8.0 |
| **After** 5 days, 20°C: | | | | | | | | | |
| Buret read. after (ml) | 5.8 | 9.6 | | | | | | 15.6 | 13.0 |
| Buret read. before (ml) | 0 | 5.8 | | | | | | 7.6 | 7.0 |
| (B) Difference, ml of "thio" | 5.8 | 3.8 | | | | | | 8.0 | 6.0 |
| (C) DO depletion, A-B (ml) | 2.0 | 4.1 | | | | | | 0.2 | 2.0 |
| **Dilution factor** | 100 | 50 | | | | | | | |
| BOD (mg/l) | 200 | 205 | | | | | | | |
| If sample was seeded with 1 ml seed: | | | | | | | | | |
| **(C)** Depletion (ml) | 2.0 | 4.1 | | | | | | Correction for 1 ml seed = $\frac{2.0}{6}$ = .33 | |
| **Correction**, seed (ml) | 0.3 | 0.3 | | | | | | | |
| (D) Corrected difference (ml) | 1.7 | 3.8 | | | | | | | |
| Dilution factor | 100 | 50 | | | | | | | |
| Corrected BOD (mg/l) (D x dilution factor) | 170 | 190 | | | | | | | |

FIGURE NO. 5 BOD DETERMINATION WORKSHEET

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* Courtesy of Water Pollution Control Federation, Manual of Practice, No. 18, p.58.

# SECTION XIII

## O & M MANUAL CHAPTER VII: RECORDS*

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* The format suggested for the table of contents page for the Records Chapter of an O & M Manual is similar, except for the Discussion portion, to the format given for this section of the Considerations Manual.

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## DISCUSSION

An important factor in any efficient wastewater treatment system is the maintenance of accurate operational and financial records. Without a record of past operational performance, it is impossible to identify trends in any process. Operating cost records are essential if meaningful budgets are to be prepared. Accurate records permit plant operating personnel and management to maintain control of their facility. This chapter of the O & M Manual should list only those records necessary for efficient operation of the treatment system.

The objective of this chapter of the O & M Manual is to describe the records and reports that should be maintained. The importance of keeping neat and accurate records should be stressed in this chapter of the manual.

The principal types of records discussed in this chapter include:

- Monthly operating report to State Water Pollution Control Agency
- Daily Log, by shift, of process operations
- Operating cost records
- Annual report to governmental body responsible for treatment system

Other records such as laboratory, maintenance and safety should be listed in this chapter. Detailed descriptions of these records should be provided in the chapters of the O & M Manual dealing with these topics.

Miscellaneous records that can be discussed include by-pass reports, chlorine failure reports and average monthly operating records.

## DAILY OPERATING LOG

Operator's worksheets should be maintained. These sheets are temporary until data is transferred to the daily operating log or they may be kept if they apply to a remote location. Information contained on these worksheets might include the following:

1. Facility influent flow (MGD).
2. Recirculation rate.
3. Grit removed.
4. Screenings removed.
5. Sludge handling data (Sludge pumping, etc.).
6. Status of secondary treatment process.
7. Visual assessment of influent, effluent and receiving stream quality.

Figure No. 6 is a sample worksheet for an anaerobic digester.

A daily operating log should be maintained. This log should be bound in notebooks to prevent the destruction or alteration of these important records. Information on this daily log should include the following:

1. Routine operational duties.
2. Unusual conditions (operational and maintenance).
3. Accidents to personnel.
4. Complaints (odor, etc.).
5. Power consumption.
6. Plant visitors.

Figure No. 7 is a sample daily operating log. The daily log utilizes two pages per day in the facility's log book. Page one is always the left hand page and contains the record of the first and second shifts. Page two, the right hand page, contains a record of the third shift's activities and the summary of the day's operation. The summary forms a basic data source for each day's entry on the monthly operating report.

DIGESTER NO. ______ DATE: ______________

| TIME | GAS METER | TEMP. | RECIRCULATING PUMP | | | HEAT EXCHANGER TEMP. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SLUDGE | | WATER | |
| | | | ON | OFF | HRS. | IN | OUT | IN | OUT |
| 24:00 | | | | | | | | | |
| 01:00 | | | | | | | | | |
| 02:00 | | | | | | | | | |
| 03:00 | | | | | | | | | |
| 04:00 | | | | | | | | | |
| 05:00 | | | | | | | | | |
| 06:00 | | | | | | | | | |
| 07:00 | | | | | | | | | |
| 08:00 | | | | | | | | | |
| 09:00 | | | | | | | | | |
| 10:00 | | | | | | | | | |
| 11:00 | | | | | | | | | |
| 12:00 | | | | | | | | | |
| 13:00 | | | | | | | | | |
| 14:00 | | | | | | | | | |
| 15:00 | | | | | | | | | |
| 16:00 | | | | | | | | | |
| 17:00 | | | | | | | | | |
| 18:00 | | | | | | | | | |
| 19:00 | | | | | | | | | |
| 20:00 | | | | | | | | | |
| 21:00 | | | | | | | | | |
| 22:00 | | | | | | | | | |
| 23:00 | | | | | | | | | |
| TOTALS | | | | | | | | | |

OPERATOR: ______________ ______________ ______________
24:00 - 08:00 08:00 - 16:00 16:00 - 24:00

FIGURE NO. 6 SAMPLE OPERATOR'S WORKSHEET - ANAEROBIC DIGESTER

## LABORATORY RECORDS*

A daily laboratory worksheet should be maintained. Information on this laboratory worksheet should include the following:

1. A summary of all lab tests run.
2. A format for calculating BOD.
3. Weather conditions (temperature, precipitation, etc.)
4. Chemicals used.

* The Laboratory Testing Chapter of the O & M Manual should contain a detailed discussion of the laboratory records recommended for use by the treatment system.

## MONTHLY REPORT TO STATE AGENCIES

The records section of the O & M Manual should explain how the State's monthly report applies to the specific treatment system at hand. Maximum usage of this State form will prevent using supplemental forms, thus eliminating unnecessary paper work. Sample forms should be provided either in this section or in the manual's appendix.

## ANNUAL REPORT

The persons preparing the O & M Manual should discuss annual reports in this section of the manual. Information on who is to prepare the report should be given.

Generally the treatment plant superintendent will be responsible for preparing an annual report. Tell whether the report is prepared at the end of the calendar or the fiscal year.

The annual report is generally divided into two parts, a Management Data Section and an Operating Data Section. Figure No. 8 lists most of the information required in the Operating Data Section of an annual report.

| PLANT INFLUENT FLOW METER | | RETURN SLUDGE | WASTE SLUDGE | AIR SUPPLIED |
|---|---|---|---|---|
| FINAL | | | | |
| INITIAL | | | | |
| TOTAL | | | | |

| GAS PRODUCED | | USED | SLUDGE PUMPED | HEAT EXCHANGER TEMPERATURE | DIGESTER TEMPERATURE |
|---|---|---|---|---|---|
| FINAL | | | | IN OUT | |
| INITIAL | | | | | ___°F |
| TOTAL | | | | ___°F ___°F | |

| HOUR | D. O. | $CL_2$ RES. |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

| CHLORINE USED | |
|---|---|
| FINAL | |
| INITIAL | |
| TOTAL | |
| BLOWER NO. 1 | |
| FINAL | |
| INITIAL | |
| TOTAL | |
| BLOWER NO. 2 | |
| FINAL | |
| INITIAL | |
| TOTAL | |

| SVI | |
|---|---|
| MLSS | |
| | |

REMARKS: 1ST SHIFT

| DESCRIPTION | QUANTITY |
|---|---|
| SCREENINGS | |
| GRIT | |
| SCUM | |

| CHECKLIST | | | |
|---|---|---|---|
| AIR COMP. | | SPRAY PUMPS | |
| BLOWERS | | GAS COMP. | |
| GAS LINES | | HEAT EXCH. | |

AIR TEMP. ___°F

SEWAGE TEMP. ___°F

WEATHER:

OPERATOR:

DATE:

| PLANT INFLUENT FLOW METER | | RETURN SLUDGE | WASTE SLUDGE | AIR SUPPLIED |
|---|---|---|---|---|
| FINAL | | | | |
| INITIAL | | | | |
| TOTAL | | | | |

| GAS PRODUCED | | USED | SLUDGE PUMPED | HEAT EXCHANGER TEMPERATURE | DIGESTER TEMPERATURE |
|---|---|---|---|---|---|
| FINAL | | | | IN OUT | |
| INITIAL | | | | | ___°F |
| TOTAL | | | | ___°F ___°F | |

| HOUR | D. O. | $CL_2$ RES. |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

| CHLORINE USED | |
|---|---|
| FINAL | |
| INITIAL | |
| TOTAL | |
| BLOWER NO. 1 | |
| FINAL | |
| INITIAL | |
| TOTAL | |
| BLOWER NO. 2 | |
| FINAL | |
| INITIAL | |
| TOTAL | |

| SVI | |
|---|---|
| MLSS | |
| | |

REMARKS: 2ND SHIFT

| DESCRIPTION | QUANTITY |
|---|---|
| SCREENINGS | |
| GRIT | |
| SCUM | |

| CHECKLIST | | | |
|---|---|---|---|
| AIR COMP. | | SPRAY PUMPS | |
| BLOWERS | | GAS COMP. | |
| GAS LINES | | HEAT EXCH. | |

AIR TEMP. ___°F

SEWAGE TEMP. ___°F

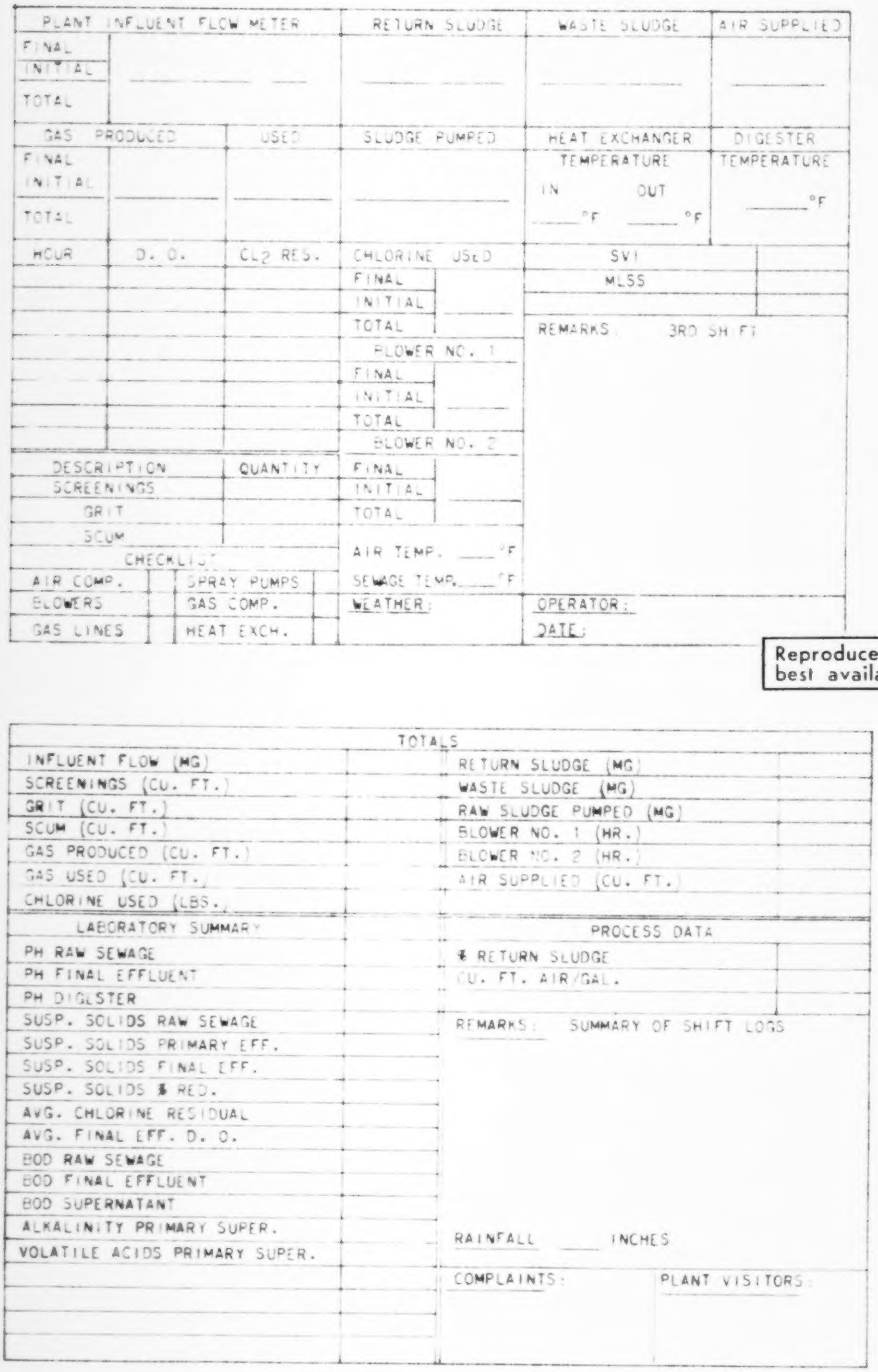
WEATHER:

OPERATOR:

DATE:

FIGURE NO. 7

SAMPLE DAILY OPERATING LOG



| PLANT INFLUENT FLOW METER | | RETURN SLUDGE | WASTE SLUDGE | AIR SUPPLIED |
|---|---|---|---|---|
| FINAL | | | | |
| INITIAL | | | | |
| TOTAL | | | | |

| GAS PRODUCED | | USED | SLUDGE PUMPED | HEAT EXCHANGER TEMPERATURE | DIGESTER TEMPERATURE |
|---|---|---|---|---|---|
| FINAL | | | | IN OUT | |
| INITIAL | | | | | ____°F |
| TOTAL | | | | ____°F ____°F | |

| HOUR | D. O. | CL2 RES. | CHLORINE USED | | SVI | |
|---|---|---|---|---|---|---|
| | | | FINAL | | MLSS | |
| | | | INITIAL | | | |
| | | | TOTAL | | REMARKS: 3RD SHIFT | |
| | | | BLOWER NO. 1 | | | |
| | | | FINAL | | | |
| | | | INITIAL | | | |
| | | | TOTAL | | | |
| | | | BLOWER NO. 2 | | | |

| DESCRIPTION | QUANTITY | |
|---|---|---|
| | | FINAL |
| SCREENINGS | | INITIAL |
| GRIT | | TOTAL |
| SCUM | | |

CHECKLIST

| | | | | |
|---|---|---|---|---|
| AIR COMP. | ☐ | SPRAY PUMPS | ☐ | |
| BLOWERS | ☐ | GAS COMP. | ☐ | |
| GAS LINES | ☐ | HEAT EXCH. | ☐ | |

AIR TEMP. ____°F

SEWAGE TEMP. ____°F

WEATHER:

OPERATOR:

DATE:

Reproduced from best available copy.

TOTALS

| | | | |
|---|---|---|---|
| INFLUENT FLOW (MG) | | RETURN SLUDGE (MG) | |
| SCREENINGS (CU. FT.) | | WASTE SLUDGE (MG) | |
| GRIT (CU. FT.) | | RAW SLUDGE PUMPED (MG) | |
| SCUM (CU. FT.) | | BLOWER NO. 1 (HR.) | |
| GAS PRODUCED (CU. FT.) | | BLOWER NO. 2 (HR.) | |
| GAS USED (CU. FT.) | | AIR SUPPLIED (CU. FT.) | |
| CHLORINE USED (LBS.) | | | |

| LABORATORY SUMMARY | | PROCESS DATA | |
|---|---|---|---|
| PH RAW SEWAGE | | % RETURN SLUDGE | |
| PH FINAL EFFLUENT | | CU. FT. AIR/GAL. | |
| PH DIGESTER | | | |
| SUSP. SOLIDS RAW SEWAGE | | REMARKS: SUMMARY OF SHIFT LOGS | |
| SUSP. SOLIDS PRIMARY EFF. | | | |
| SUSP. SOLIDS FINAL EFF. | | | |
| SUSP. SOLIDS % RED. | | | |
| AVG. CHLORINE RESIDUAL | | | |
| AVG. FINAL EFF. D. O. | | | |
| BOD RAW SEWAGE | | | |
| BOD FINAL EFFLUENT | | | |
| BOD SUPERNATANT | | | |
| ALKALINITY PRIMARY SUPER. | | RAINFALL ____ INCHES | |
| VOLATILE ACIDS PRIMARY SUPER. | | | |
| | | COMPLAINTS: | PLANT VISITORS: |
| | | | |
| | | | |
| | | | |

FIGURE NO. 7 CONTINUED

SAMPLE DAILY OPERATING LOG

In addition to the items shown in Figure No. 8, the annual report should include the following information:

Management Data:*

1. Total historical capital cost.
2. Total historical capital cost depreciated.
3. Replacement cost.
4. Replacement cost depreciated.

* The debt service should be included in the management data portion of the annual report and should list the outstanding debt schedule.

Operating Data*

The unit operating costs per million gallons for the year should be given using the following costs:

1. All cost exclusive of debt service.
2. All cost including debt service.

*Provide a graph showing at least 10 years of record (if available)

1. Average daily flow for each month.
2. Average daily flow for year.
3. Project curve for next 5 years.
4. Total unit cost for the year.

# ANNUAL REPORT

OPERATING DATA

CONNECTED POPULATION . . . . . . . . . . . . . . . . . . . . . . . . .

EQUIVALENT POPULATION . . . . . . . . . . . . . . . . . . . . . . . .

FLOW (MGD) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

pH
- INFLUENT . . . . . . . . . . . . . . . . . . . . . . . . . . . .
- EFFLUENT . . . . . . . . . . . . . . . . . . . . . . . . . . . .

SCREENINGS (CU. FT. PER DAY ) . . . . . . . . . . . . . . . . . . . .

BOD (mg/l)
- INFLUENT . . . . . . . . . . . . . . . . . . . . . . . . . . . .
- EFFLUENT . . . . . . . . . . . . . . . . . . . . . . . . . . . .
- REDUCTION (%) . . . . . . . . . . . . . . . . . . . . . . . . .

SUSPENDED SOLIDS (mg/l)
- INFLUENT . . . . . . . . . . . . . . . . . . . . . . . . . . . .
- EFFLUENT . . . . . . . . . . . . . . . . . . . . . . . . . . . .
- REDUCTION (%) . . . . . . . . . . . . . . . . . . . . . . . . .

CHLORINE
- TOTAL USED (LB.) . . . . . . . . . . . . . . . . . . . . . . . .
- RESIDUAL (mg/l) . . . . . . . . . . . . . . . . . . . . . . . . .

RAW SLUDGE
- AMOUNT (GAL/DAY) . . . . . . . . . . . . . . . . . . . . . . . .
- TOTAL SOLIDS (%) . . . . . . . . . . . . . . . . . . . . . . . .
- VOLATILE SOLIDS (%) . . . . . . . . . . . . . . . . . . . . . . .

DIGESTED SLUDGE
- VOLUME WITHDRAWN (GAL/DAY) . . . . . . . . . . . . . . . . . . .
- MOISTURE (%) . . . . . . . . . . . . . . . . . . . . . . . . . .
- VOLATILE SOLIDS (%) . . . . . . . . . . . . . . . . . . . . . . .

GAS PRODUCTION
- CU. FT. PER DAY . . . . . . . . . . . . . . . . . . . . . . . . .
- METHANE (%) . . . . . . . . . . . . . . . . . . . . . . . . . . .

MANAGEMENT DATA

OPERATING EXPENSE ($)
- SALARIES (OPERATING PERSONNEL) . . . . . . . . . . . . . . . . . .
- SALARIES (PREVENTIVE MAINTENANCE) . . . . . . . . . . . . . . . . .
- SALARIES (CORRECTIVE MAINTENANCE) . . . . . . . . . . . . . . . . .
- SALARIES (CLERICAL STAFF) . . . . . . . . . . . . . . . . . . . . .
- SALARIES (ADMINISTRATIVE STAFF) . . . . . . . . . . . . . . . . . .
- CHEMICALS . . . . . . . . . . . . . . . . . . . . . . . . . . . .
- LABORATORY . . . . . . . . . . . . . . . . . . . . . . . . . . . .
- TREATMENT . . . . . . . . . . . . . . . . . . . . . . . . . . . .
- VEHICLE OPERATION . . . . . . . . . . . . . . . . . . . . . . . .

MISCELLANEOUS . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

TOTAL EXPENSES ($) . . . . . . . . . . . . . . . . . . . . . . . . . .

BUDGET OR REVENUE ($) . . . . . . . . . . . . . . . . . . . . . . . .

FIGURE NO. 8 SAMPLE: ANNUAL REPORT

## MAINTENANCE RECORDS*

Physical plant records should be available for reference at the plant and should include:

1. Plant O & M Manual
2. As-built engineering drawings
3. Copy of construction specifications
4. Equipment suppliers' manuals
5. Piping and wiring diagrams
6. Data cards on all equipment
7. Facility hydraulic profile
8. Inventory of industrial waste contributors
9. Construction photographs

* A comprehensive discussion of maintenance records for major equipment items should be provided in the Maintenance Chapter of the Manual.

## OPERATING COSTS AND RECORD KEEPING

The major categories of operating costs are labor, utilities, chemicals and supplies. Labor should be broken down into operation, administration and maintenance. Utilities include electricity, fuel oil, telephone, gas and potable water. Chemicals should be limited to those used in the treatment processes. Supplies include lab chemicals, cleaning materials, maintenance supplies and other expendable items. This section of the manual should provide a suggested operating cost breakdown for the treatment system.

Costs should include information on unit costs, total costs and amounts/ quantities used. Any cost accounting system should be compatible with the parent governmental body accounting system.

The Water Pollution Control Federation Manual of Practice No. 10, "Uniform System of Accounts for Wastewater Utilities" gives the following breakdown for operating expenses:

Collection system expenses
Wastewater pumping expense
Wastewater treatment expense
Users' accounting and collecting expenses
Administration and general expense

An important operating cost is that of insurance for the wastewater treatment system. A record system for monitoring this cost should be recommended.

## PERSONNEL RECORDS

Records that reflect such things as training individuals have received and employee turnover rate are valuable to treatment system management. A personnel records procedure should be recommended in this section of the manual.

## EMERGENCY CONDITIONS RECORD

A record of emergency conditions affecting the treatment system should be maintained. A system for maintaining these records should be recommended in this section of the manual. These emergency condition records might include bypass reports and records of deteriorated effluent conditions.

# SECTION XIV

## O & M MANUAL CHAPTER VIII: MAINTENANCE*

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* The format suggested for the table of contents page for the Maintenance Chapter of an O & M Manual is identical to the format given for this section of the Considerations Manual.

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## GENERAL

### Purpose

This portion of the manual's maintenance chapter should discuss the importance of maintenance to overall treatment plant performance. The treatment plant must be recognized as a highly specialized and complex manufacturing facility producing an acceptable effluent. It is the plant management's responsibility to produce this effluent at the lowest unit cost and at the highest quality possible. A key to fulfilling this responsibility is a sound maintenance management program. If the person preparing an O & M Manual relates the importance of maintenance to operating personnel, it can be an important factor in moving a treatment system toward a sound maintenance program. For additional assistance on maintenance management systems, preparers of O & M Manuals should consult the EPA manual entitled "Maintenance Management Systems for Municipal Wastewater Facilities", Contract No. 68-01-0341.

### Scope

The scope of the maintenance management system being recommended should be discussed in this portion of the manual. The reasoning behind the selection of the system should be included. Any input obtained from operating personnel on maintenance topics should be mentioned. The flexibility and limitations of the maintenance system should be discussed. This portion of the manual should inform the operating personnel of their maintenance system's overall capabilities.

### Basic Features of the Maintenance Management System*

This section of the manual should outline the basic features of a complete maintenance management system. The following is a list of the basic features which should be included in this section and should be applicable to all plants regardless of treatment type or size:

---

* The EPA Manual entitled "Maintenance Management Systems for Municipal Wastewater Facilities", Contract No. 68-01-0341 contains detailed discussions on each of these features.

- Equipment Record System
- Planning and Scheduling
- Storeroom and Inventory System
- Maintenance Personnel
- Cost and Budgets for Maintenance Operations

## EQUIPMENT RECORD SYSTEM

The persons preparing the Maintenance chapter of an O & M Manual should recommend an equipment record system for the facility. The facility owner should be involved in selecting the system to be recommended. The equipment record system should contain information on each item of equipment. This system may be only one card on each item of equipment, a number of cards for each item or for larger plants, a combination of information cards and data maintained on a computer.

### Equipment Numbering System

The first step in establishing an equipment record system is to select an equipment numbering system that best satisfies the needs of the particular treatment facility. Each item of equipment in the plant requiring maintenance should be assigned a number for easy identification and to help ensure that all equipment receives proper attention. One approach is to start numbering the equipment beginning with the point where the wastewater enters the plant and continue to number each item of equipment as the wastewater continues through the plant, followed by suitable coverage of process side streams.

A second approach is to number all equipment in a specified area or building with a range of numbers such as 100-120 and the equipment in another area 200-230. This system of block numbering for a specified area aids in locating equipment, permits adding equipment, and setting up a numbering system for the equipment card file.

A third approach is to divide the facility into nine stages and assigning 1000 numbers to each, the stages may be further broken down to 100 series numbers to identify specific items and to allow for future additional units.

Equipment Catalog

After each item of equipment has been assigned a number, a catalog should be prepared that lists equipment descriptions, locations and equipment numbers. The catalog will provide a convenient reference for locating equipment and identifying equipment numbers.

Card File Systems

Various card files are available such as single equipment cards, a three card system, edge-punched cards and card files which are set upright or are located in a horizontal position and have an edge exposed on which color tabs are placed. These color coding tabs mark the month and week in which preventive maintenance work is to be performed. These card systems are readily available through most office supply agencies and the systems can be adapted to plants based on their individual needs. The person recommending the equipment record system should ensure the system contains the following information:

- Description of equipment and equipment number with location in plant.
- Supplier with address, representative, phone number, date of purchase with cost.
- Size, model, type and serial number.

- Electrical and/or mechanical data.

- Inventory of spare parts on hand.

- Preventive maintenance (PM) items to be accomplished with their frequency. Space to note when PM was performed, by whom and pertinent comments. Data on man-hours, cost, and material or supplies consumed.

- Information on corrective maintenance work should be maintained in a manner similar to that outlined above for preventive maintenance.

- A system to compile this information for use in determining costs and for future use in budget development.

The following information describes some of the card systems available for maintaining equipment records:

Single Card System for Preventive Maintenance

This system uses ordinary ruled 5" x 8" cards or 8½" x 11" cards. This system is adequate for small plants where a single supervisor is responsible for maintenance and record keeping is a duty he must perform by himself. Each item of equipment should have a single card either filed by equipment number or filed alphabetically. The equipment card face should contain the following information:

- Name and location of equipment or structure
- Name of manufacturer, supplier, or builder
- Cost and installation date
- Type, style, model
- Capacity, size, rating
- Serial and code numbers

- Nature and frequency of maintenance
- Proper lubricants, coatings

The backs of the cards are used to record the date the work is performed, the type of work, and the initials of the person performing the tasks. Corrective maintenance tasks may also be noted on the back of the card to provide a complete record of all maintenance work performed on the item of equipment. Figure No. 9 shows the face and back of a sample card from a single card system.

### Edge-punched Card System for Preventive Maintenance

Edge-punched cards offer advantages for all but the smallest installations. The edge-punched card type of record systems are available with either a hand-sorted punched card filing system or electromagnetic filing system. The cards have rows of holes prepunched along each edge. The face and back of the card are used for a written record of the desired data. Each hole or combination of holes along the edge is assigned a specific meaning.

To designate, for example, a semiannual service, the paper between the edge of the card and the hole marked "semiannual" is removed, thus forming a notch. To select this card from a pack of cards, and all others calling for a semiannual service, the pack is aligned in a vertical position with the desired hole in the upper edge. As indicated in Figure No. 10 a needle similar to an ice pick is then passed through the hole. Upon fanning out the pack and lifting it with the needle, all cards notched in the selected position drop from the pack, while those not notched remain suspended from the needle.

Anywhere from one to five cards can be prepared for any one item of equipment, depending on the frequencies of maintenance work required. More effort is required to place data on extra cards, but it is felt the ease with which personnel can identify work assigned on a particular

| JAN. | FEB. | MAR. | APR. | MAY | JUNE | JULY | AUG. | SEPT. | OCT. | NOV. | DEC. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 |

| | |
|---|---|
| Preventive Maintenance Program | Equipment Record Number |

| EQUIPMENT DESCRIPTION | | ELECTRICAL OR MECHANICAL DATA |
|---|---|---|
| Name | | Size |
| Serial No. | | Model |
| Vendor | | Type |
| Vendor Address | | |
| Vendor Rep. | Phone | |
| Initial Cost | Date | |

| WORK TO BE DONE | FREQUENCY | TIME |
|---|---|---|
| | | |
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| DATE | WORK DONE | SIGNED | DATE | WORK DONE | SIGNED | DATE | WORK DONE | SIGNED |
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FIGURE NO. 9 SAMPLE EQUIPMENT RECORD CARD

Courtesy of Journal Water Pollution Control Federation, Vol. 26, p. 1399 (Nov. 1954)

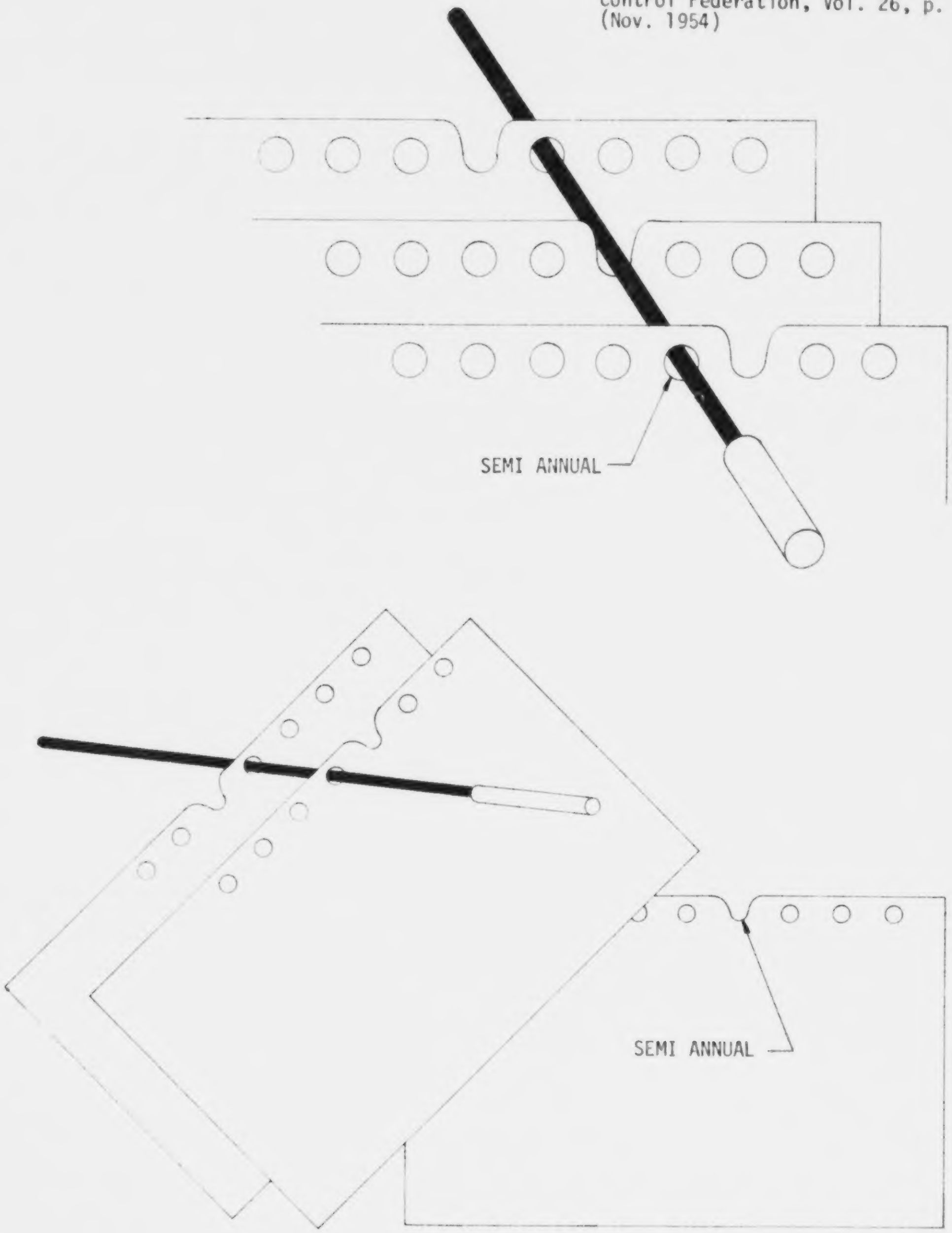

SEMI ANNUAL
SEMI ANNUAL

FIGURE 10. PRINCIPLE OF EDGE-PUNCHED CARD RECORD SYSTEM FOR MAINTENANCE PROGRAMS.

day more than compensates for this initial work. Figure No. 11 is a typical card for the weekly frequency group.

## Three Card System

The three card system may be used by large or small facilities. Several types of three card systems are currently available. The following is an outline of the basic information which may be maintained on each of the three cards:

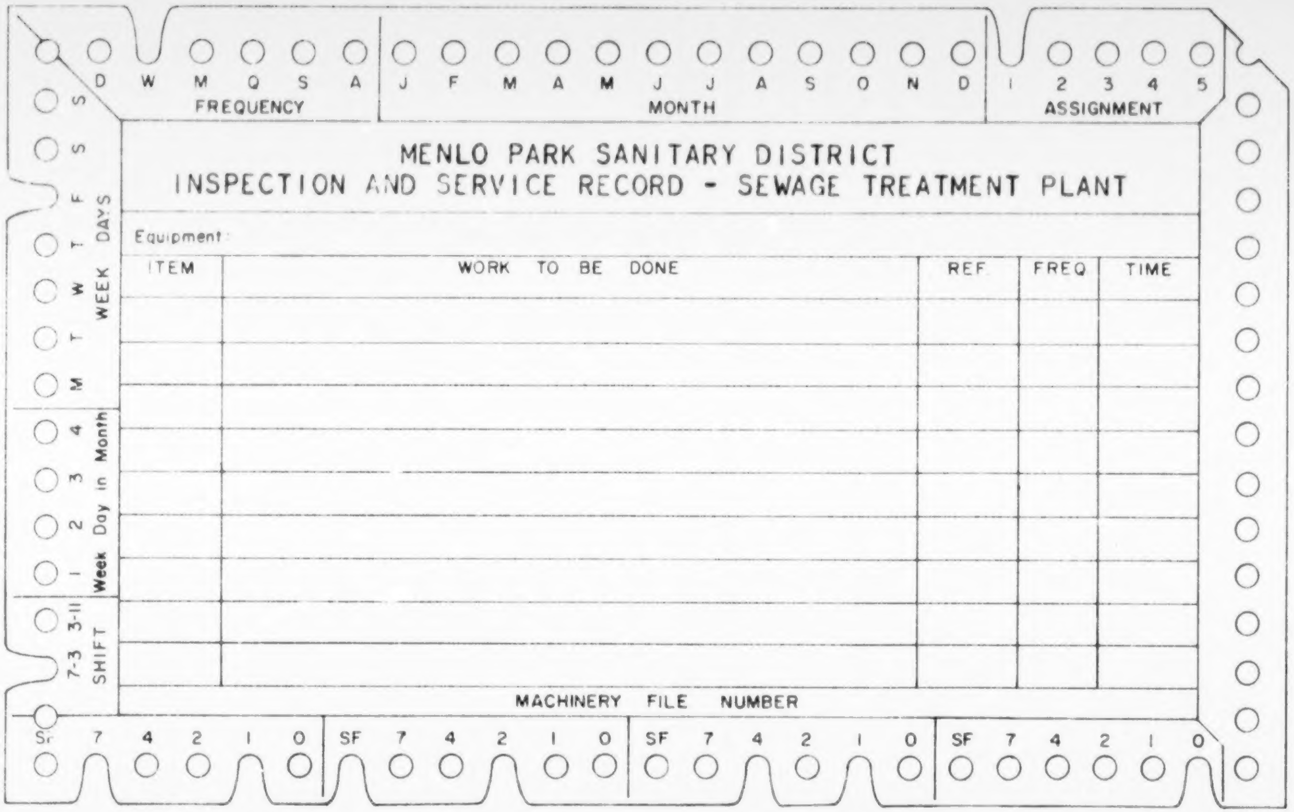
A. The first card has equipment number, description, nameplate data, vendor name, cost information, location, mechanical and/or electrical data on the front of the card. A spare parts list and space for additional information is on the reverse side of the card.

B. The second card contains equipment item, number, preventive maintenance tasks and their frequencies. The card should have a metal tab or some other method to identify when a maintenance task is to be performed.

C. The third card contains item, department, preventive maintenance work performed, with labor hours, labor cost, materials, and total cost. The remaining side contains corrective maintenance work performed with man-hours and cost data as outlined for preventive maintenance. The date is also entered to identify when the work was performed.

## Computerized PM and Lubrication Program

Some facilities may find it economical to computerize their maintenance programs. The following description outlines the capabilities and basic features of such a computer system. The goal of this system is to establish a closed-loop maintenance system that would permit one



D W M Q S A
FREQUENCY

J F M A M J J A S O N D
MONTH

1 2 3 4 5
ASSIGNMENT

MENLO PARK SANITARY DISTRICT
INSPECTION AND SERVICE RECORD - SEWAGE TREATMENT PLANT

Equipment:

| ITEM | WORK TO BE DONE | REF. | FREQ | TIME |
|---|---|---|---|---|
| | | | | |
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S S F T W T M
WEEK DAYS

4 3 2 1
Week Day in Month

3-11 7-3
SHIFT

MACHINERY FILE NUMBER
SF 7 4 2 1 0 SF 7 4 2 1 0 SF 7 4 2 1 0 SF 7 4 2 1 0

FIGURE NO. 11 SAMPLE CARD FOR THE WEEKLY FREQUENCY GROUP

Courtesy of Journal Water Pollution
Control Federation, Vol. 26, p. 1399
(Nov. 1954)

reporting plan to furnish a total documented control readout of scheduling, cost, equipment history, and manpower requirements.

The system is based on total plant rather than area approach. The first step in developing the system is to establish PM requirements on each piece of equipment. This is done considering the following equipment parameters:

- Number of hours operated
- Severity of use
- Condition and age

A program coordinator must be responsible for programming each piece of equipment into the system. He must also perform the following tasks:

- Ensure computer input cards are properly printed
- Field check the system
- Monitor printouts
- Coordinate with key maintenance personnel

The PM time estimates and cost information are input to the computer to determine budget expenditures in relation to services performed. This system provides the following functions:

- Schedules work
- Verifies completion of PM function
- Prints out maintenance costs in labor and parts
- Stores current information on materials and spare parts
- Maintains information on work order backlog
- Stores information on available resources (craftsmen, mobile equipment, etc.)

Work order cards are prepared in advance by data processing and distributed to the maintenance section. Upon completion of the work, the work order is returned to be recorded. The work order cards are reviewed and sent to data processing where data is placed into the computerized equipment maintenance record.

### Nameplate Data

In addition to recommending the equipment record system, the persons preparing the manual should provide the nameplate data for all major items of equipment. This data should be placed on the appropriate card from the equipment record system. The nameplate data should include but not be limited to the following information:

1. Equipment Name
2. Vendor
3. Model Number
4. Serial Number
5. Make or Type
6. Pertinent Mechanical/Electrical Data

## PLANNING AND SCHEDULING

Wastewater treatment facilities do not observe holidays and vacation shutdowns. The facilities do experience variations in flows and maintenance work loads. Under these conditions, it is imperative that maintenance be planned and scheduled so that there is no idle time or peak work load period. Maintenance scheduling will vary with the size and complexity of the facility and with the type of personnel available. However, proper management will provide a maintenance plan no matter what the facility size.

Maintenance planning and scheduling involves time, personnel, equipment, schedules, costs, work orders and priorities. This section of the O & M Manual should make recommendations on planning and scheduling maintenance tasks. This section should also outline the use of chart boards and work orders to aid in planning and scheduling.

In planning and scheduling preventive maintenance work, the size and capabilities of the maintenance staff will affect the amount of maintenance work which can be accomplished. Corrective maintenance functions should be considered when setting up the preventive maintenance program. Corrective maintenance requirements can be estimated from past experience and maintenance history records. Maintenance labor standards will aid in determining the time required to accomplish specific maintenance tasks. Provisions should be made in planning and scheduling to allow time in the maintenance schedule to perform corrective maintenance. The extent to which the corrective maintenance can be planned for will aid in determining the actual time which will be available to perform preventive maintenance tasks.

A schedule chart with priorities of subjects, personnel and time is a convenient aid to reduce impulse searches for work for idle personnel. The schedule chart may be divided into daily, weekly, monthly, quarterly, semiannually, and yearly sections so that the entire range of maintenance functions can be observed. Color tabs and labels can be coded to account for all personnel and their duties at a specific point in time. The removal of the tag from the schedule chart board indicates the work is underway or has been completed. The chart board provides a graphic indication of progress and manpower usage. The chart board also provides a graphic indication of tasks that are running behind. Chart boards are available from most office supply companies. The size, method of use, and detail of the schedule chart board depends upon the facility management.

Indoor and outdoor maintenance should be scheduled to take advantage of open or inclement weather, low load or flow periods and other variable conditions beyond the control of the operating staff.

All maintenance work should be scheduled just as the operating routine has to be scheduled. Preventive maintenance should not be a haphazard procedure to be done if time permits.

Some type of maintenance must be scheduled for the once a year opportunity when the plant load normally is at its lowest. This may be the time to drain, check, repair, and paint the clarifier and certain underwater items of equipment.

There are seasonal items to be scheduled such as:

1. Clearing sludge from drying beds
2. Lawn and landscaping work
3. Snow removal
4. Exterior painting

There are items which may occur annually or others with as much as 4 or 5 year intervals. The items include:

1. Painting
2. Roofing
3. Paving and road repairs
4. Fencing
5. Insulating
6. Electrical system upgrading
7. Plumbing revisions

The manufacturer's maintenance manual is generally the best guide for preventive maintenance instructions for any item of equipment. Most equipment is mass produced on a competitive basis and the cost of its maintenance should be consistent with its value, life expectancy and replacement costs. Equipment should be rated as to its critical position in the plant operating system and its maintenance priority.

Unnecessary or too frequent preventive maintenance can be as wasteful as improper maintenance procedures. The preparer of the O & M Manual should assist treatment system management to determine the optimum preventive maintenance schedule and replacement program.

The plant maintenance personnel should be cautioned to continuously monitor the plant operations to determine other maintenance work to be accomplished. When emergencies and breakdowns occur, these tasks must be reviewed and work initiated to return the plant to its full capacity and efficiency.

Owners should be guided to arrangements with contractors and repair services to aid the facility maintenance personnel in performing various maintenance tasks and emergency repairs. These tasks may include electrical and mechanical problems or malfunctions in the chlorination system. Other general maintenance tasks as snow removal, ground work, painting, or other minor functions can be contracted out. A suggested list of contractors and contract jobs should be provided in the Contract Maintenance portion of the Manual's Maintenance Chapter.

A work order system should be established to initiate all corrective maintenance tasks. The work order system will aid in identifying work to be accomplished, procedure priority, and information on any special aspects of the job. A log of the work orders will provide a record of when the work order was initiated and completed. The work orders should be numbered to provide a means of maintaining accountability. The following two figures are examples of work orders. Figure No. 12 outlines the possible format for a small plant. Figure No. 13 provides a format for the information which would be required by a large facility.

## STOREROOM AND INVENTORY SYSTEM

This section should outline the importance of having a storeroom and inventory system with recommendations on establishing such a system for the particular plant.

## WORK ORDER

WORK ORDER NO. ____________________ DATE: ____________________

WORK TO BE PERFORMED:

MATERIALS REQUIRED:

WORK PERFORMED BY:

1. ________________________________________ __________ HOURS
2. ________________________________________ __________ HOURS
3. ________________________________________ __________ HOURS
4. ________________________________________ __________ HOURS

WORK COMPLETED:

SIGNED: ____________________________

DATE: ______________________________

COMMENTS:

FIGURE NO. 12 SAMPLE WORK ORDER

Date ____________

Work Order No. ______________________

| | | |
|---|---|---|
| Location | Requested By:<br><br>(Phone) | Priority: |

| Equipment Name | No. |
|---|---|
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☐ Inspect ☐ Replace ☐ Service

☐ Repair ☐ Overhaul ☐ Paint

Work Description

Work Performed/Comments

Job Estimate

Labor $ ____________

Material $ ____________

____________________
Maintenance Superintendent

Work Record

| Personnel Assigned | Manhours | Date | Work Done | Parts & Materials |
|---|---|---|---|---|
| | | | | |
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| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Total | | | | |

Work Completed By ______________________________ Date __________

Work Accepted By ______________________________ Date __________

FIGURE NO. 13

SAMPLE: WORK ORDER

A central storeroom for spare parts, equipment, and supplies should be maintained. A review of the equipment and the manufacturer's recommendations will aid in determining what spare parts and miscellaneous supplies should be maintained. The spare parts and components should be listed in a central catalog and assigned a number. A minimum and maximum quantity to be stocked should be established. A card system to record information on quantity, item number, description, when last purchased, cost, date, vendor, and other information is helpful. A system for arranging items in the storeroom should be established to aid in locating items. When items are taken from this stock, the date and use should be noted on the card file. For items which may be long lead items, a reorder point should be established to aid in resupply. A central storeroom may be used with other municipal divisions with spare parts for the wastewater plant, filtration plant, and streets divisions. A storeroom clerk could maintain accountability of the parts, keep records, initiate information for purchase orders, and handle a stores withdrawal system to maintain information on parts obtained by each division. A store ticket or withdrawal slip should be completed when any item is used. The ticket will be a record showing when the item was used and for what purpose. This information can be transferred to the card for the item to aid in determining when reorder is required. This system will provide an inventory of items currently in stock.

A purchase order system should be established. The system should provide a record of the date an item was ordered and when received, quantity, unit cost, total cost, supplier and item destination (stock, preventive maintenance or corrective maintenance). Standing purchase orders can be used effectively for spreading out delivery of large quantities of supplies.

## MAINTENANCE PERSONNEL

It should be noted in this section that only properly trained personnel can be expected to perform satisfactory inspections, repairs and preventive maintenance tasks. Properly trained personnel should possess a thorough knowledge of the functions and operations of their equipment and the procedures for servicing it. A good maintenance management program must consider the limitations of plant operators and maintenance personnel. The program must also consider obtaining outside consultants or factory representatives to perform certain required maintenance functions.

This section should make reference to the Personnel chapter of the manual which provides job titles, job descriptions, and qualifications for maintenance personnel. Any general information regarding maintenance personnel or particular information on possible sources of maintenance help should be included in this section.

## COSTS AND BUDGETS FOR MAINTENANCE OPERATIONS

This section should provide guidelines for the determination of maintenance cost and the development of maintenance budgets.

Plant information on maintenance cost and the development of a maintenance budget are very important for their incorporation into the plant's total operation and maintenance budget. Before an accurate estimate of maintenance cost can be made or a sound maintenance budget can be prepared, it is necessary to divide the maintenance operations into service categories such as preventive maintenance, corrective maintenance, and major repairs or alterations. With the maintenance operations defined, the information in the equipment record system on work performed, work contracted out, items used from storeroom stock and purchased, and a breakdown of man-hours provide information on maintenance cost. Using these costs and making allowances for equipment replacement, expansion, and information on maintenance history for the plant, the maintenance budget can be developed.

The needed information on contract maintenance and cost of items on purchase orders may require the plant to set up a filing system to retain this information. The information could be maintained by log books with file folders to maintain purchase orders, receipts, and other important papers.

For plants in which most personnel are performing certain maintenance duties, the man-hours for each employee should be broken into each half hour of the work shift with charge numbers established to separate operations and maintenance work. For the maintenance work, individual charge numbers should be established to cover each phase of maintenance work such as preventive maintenance, corrective maintenance, and special charge numbers to handle major repairs and alterations.

The O & M Manual preparer should recommend that the facility's personnel work in conjunction with the municipal bookkeeping department to maintain the information on cost and man-hours.

## MISCELLANEOUS MAINTENANCE RECORDS

In conjunction with the maintenance records previously discussed, logs are often kept of preventive and corrective maintenance work accomplished with description, man-hours, cost, date, and maintenance personnel who accomplished work. This is especially helpful at unattended pumping stations and other remote facilities.

History records should be maintained with maintenance cards for the previous years and breakdown reports for all major problems encountered.

These records will aid in budget planning, scheduling, manpower, operating expenses, and other needed information as required. Such records will assist in determining the time at which it is more economical to replace an item of equipment instead of repairing it.

## HOUSEKEEPING

This section of the O & M Manual should recommend housekeeping activities to be performed within the treatment system.

Housekeeping of buildings and grounds should receive the same attention as the operating equipment. A clean and neat appearance with unnecessary odors eliminated will promote public support for the facility. Routine housekeeping can be incorporated into shift standard operating procedures.

Process equipment should be cleaned and painted as required for appearance and to minimize odor sources. The doors, windows, floors, walls, and other areas should be kept clean and in good repair. Outside maintenance work such as mowing, snow removal, painting, cleaning gutters and drains should be scheduled as required.

## SPECIAL TOOLS AND EQUIPMENT

This section of an O & M Manual should provide recommendations on tool room procedures, the use of tool boards, and maintenance skills required for all special tools.

A review of the work to be performed by the maintenance personnel will aid in developing a list of the tools and equipment required for the facility. The tools and equipment should be maintained in good working order and available when required. Where some items may be required in more than one location, this should be taken into account.

It is suggested that maintenance tools and supplies should not be placed any more than 100 to 200 feet from the point or points of use. Tool boards with specialized or frequently used tools should be located with appropriate equipment where required.

Facilities large enough to warrant a central tool room should maintain a complete tool inventory. Tools should be issued under a tool check control system. All tools should be regularly checked for their condition in terms of personnel safety and equipment protection.

## LUBRICATION

The Lubrication section of an O & M Manual should appropriately reference each equipment manufacturer's lubrication specification. An interchangable lubricants chart should be provided in this section. This section should contain information on the use of color coded lubrication tags for all equipment. Sample forms for recording quantities of lubricants consumed and in stock should be included. A sample lubrication route should be outlined to assist maintenance supervisors in developing lubrication routes for the facility.

The following comments are provided to assist persons preparing the lubrication portion of the O & M Manual.

Those responsible for preventive maintenance should also be responsible for lubrication. Their duties should include the following:

1. Conduct lubrication studies.
2. Prepare lubrication specifications.
3. Establish schedules.
4. Train lubricators.
5. Standardize application methods.
6. Maintain consumption and inventory records.
7. Establish proper handling and storage.
8. Investigate new lubricants; evaluate and revise specifications as necessary.
9. Standardize lubricants whenever possible to eliminate stocks of identical material under various trade names.

The most important step in establishing a lubrication system involves the gathering of basic lubrication data. Lubrication specifications can be developed from manufacturers' lubrication recommendations, ASLE and ASTM Standards. Lubrication routes should be established and every item of equipment given a route number. Lubrication points, types and frequencies should be defined for each item of equipment. All data pertinent to lubrication of selected equipment should be assembled into a lubrication guidebook. Equipment can be color coded with decals to indicate point of service, frequency of application, and type lubricant. Specifying the highest grade lubricant required for more than one application and specifying a single mid-range viscosity oil to replace several within a certain viscosity range are two methods for consolidation of lubricants. Many plants have successfully computerized their lubrication programs.

Each manufacturer of equipment will very likely specify some one or more trade name lubricants by the producers number or by an SAE number (Society of Automotive Engineers) or some other designation. This may result in numerous trade named lubricants being designated for the treatment facility equipment. A standard designation has been prepared for all comparable and interchangeable lubricants and indicated on an extensive tabular chart by Plant Engineering Magazine (August 22, 1968) whereby each type lubricant is assigned a "PE" number. The use of this designation in buying lubricants will very likely reduce the variety and inventory of products required at the treatment works.

The lubrication frequency is determined by many factors but a lubrication schedule must be established and followed to insure proper operation of the facility. The equipment card for each piece of equipment requiring lubrication should list the lubricant to be used and frequency advisable for efficient operation. For convenience and simplification of the lubrication process, a color coded tag or decal label can be used to identify the part, frequency and type of lubricant required for moving part in question. A suggested color code for various categories is:

| Color & Type | Frequency |
|---|---|
| Blue - Gear Lube | Daily |
| White - Spindle Oil | Weekly |

| Color & Type (Cont.) | Frequency (Cont.) |
|---|---|
| Green - Way Oil | Monthly |
| Red - Hydraulic Oil | Semi-Annually |
| Brown - Grease | Annually |

The tag should also indicate the appropriate lubricant.

The plant size will determine the man-hours required for the lubrication routine. The same lubricator should perform the service each time if possible in order to narrow the range or responsibility for lubrication activities. A fixed hour or day should be established for the routine when possible and a record filed on completion of the routine. A master card may be used to facilitate routing and recording operations. In large operations a computer printout for the various frequencies and lubricants may be of assistance in reducing time requirements. Machine number and data may be key punched for the preventive maintenance supervisor and completed route records filed with him.

Oil change schedules and operations must also be maintained and recorded with the maintenance supervisor. Oil must be sampled to determine when changes are required. Where large quantities of oil are required and oil changes are necessary, the facility may justify the use of oil centrifuges, filters or other clean process to permit the reuse of the purified or reconditioned oil.

Air conditioning equipment, heat exchangers and related services require coolants and antifreeze liquids for operations under wide ranges of temperature and service conditions. These liquids and their concentration must be checked and records made of routine procedures in a manner similar to those for lubrication oils.

### MAJOR EQUIPMENT INFORMATION

The Maintenance chapter of the manual should have a portion which lists each major item of electrical and mechanical equipment. The basic maintenance considerations for each item of equipment are usually found in the manufacturer's catalog. The person preparing the O & M Manual should determine if the manufacturer's catalog contains an adequate maintenance section that is presented in a usable form. If the catalog information is adequate, it should be properly referenced in this section of the O & M Manual. In referencing these catalogs a numerical system patterned after the equipment numbering system can be used.

If the manufacturer's maintenance information is not considered adequate, the person developing the O & M Manual should prepare detailed maintenance guidelines for the item of equipment. These maintenance guidelines can be included in this section of the manual or may be bound separately.

This section should also outline the procedure for ordering parts/components or new items of equipment. This information should be provided for each major item of equipment.

## WARRANTY PROVISIONS

Most facilities are constructed to include a one-year guarantee period. During this period, the contractor has the responsibility to repair, correct, or replace any equipment or material that fails to perform in accordance with the terms and provisions of the contract. This section should include a caution that alteration of supplied equipment by facility personnel, without the knowledge and consent of the contractor and manufacturer, may result in refusal of these parties to accept responsibility for any subsequent problems. Equipment which is not regularly in service during the guarantee period must be maintained and should be operated periodically to prevent problems which might arise due to the equipment not being operated. The fact that a guarantee is in effect should not be cause to allow improper maintenance or operation of equipment and thus reduce its useful life.

The O & M Manual should provide a listing of all equipment guaranteed and pertinent features of each guarantee. Copies of the warranties should be included in the Manual's Appendix.

## CONTRACT MAINTENANCE

Due to plant size, complexity of equipment and/or maintenance personnel qualifications, the facility may find it feasible to contract some maintenance work. Many equipment manufacturers will provide maintenance service for their equipment on a contract basis. However, contracting routine inspections, lubrication, and minor parts replacement can become very costly. Plant personnel should develop their maintenance capabilities in order to perform all but the most complex tasks. The manual should have a suggested list of contractors and contract jobs for the particular facility based upon its capabilities.

To provide additional information on maintenance systems, EPA has developed a manual entitled "A Planned Maintenance Management Program", Project No. 11010GWI.

# SECTION XV

## O & M MANUAL CHAPTER IX: EMERGENCY OPERATING AND RESPONSE PROGRAM*

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* The format suggested for the table of contents page for the Emergency Operating and Response Program Chapter of an O & M Manual is similar, except for the Discussion and Checklist portion, to the format given for this section of the Considerations Manual.

## DISCUSSION

Emergency conditions can be imposed on a treatment system by natural disasters, strikes, civil disorders and equipment failures. Emergency planning is essential to insure continued effective operation during emergencies. The care and detail used in preparing this chapter of an O & M Manual will directly affect the adequacy of the treatment system's emergency operating and response program.

This section of the O & M Manual gives the treatment system's emergency response plan for insuring the effective continued operation of the wastewater treatment system under emergency conditions imposed by catastrophe, failure of process or equipment or unavoidable shutdown of components. (NOTE: The Emergency Operating and Response Plan chapter may be bound separately.)

The EPA Construction Grants Program requires that the grantee provide, for each grant assisted plant, an emergency operating and response program in accordance with Section 35.935-12 of 40 CFR, Part 35.

The Environmental Protection Agency has developed two manuals entitled, "Emergency Operating Procedures for Municipal Wastewater Treatment Facilities", and "Emergency Response Programs for Municipal Wastewater Treatment Facilities, State-Local Aspects", both under Contract No. 68-01-0341 to assist in the preparation of local emergency plans. Another EPA report entitled, "Design Criteria for Mechanical, Electric and Fluid System and Component Reliability", under Contract No. 68-01-0001 also contains information related to emergency planning.

Included in this manual are a list of general emergency planning considerations and a checklist for preparing an emergency operating plan.

### General Considerations

The persons preparing an O & M Manual are responsible for developing the basic emergency response program guidelines for the treatment system.

This program will be outlined in the Emergency Operating and Response Program chapter of the facility's operation and maintenance manual. The following are general considerations for preparing this portion of an operation and maintenance manual:

1. Recommend a sewer ordinance for the protection of the collection system, treatment facility, receiving waters, and the public.

2. Recommend a system for maintaining adequate engineering drawings of the wastewater treatment system.

3. Provide facilities for chlorination during emergencies affecting the system.

4. Outline procedure for notifying Federal/State Regulatory Agencies of discharges of raw or inadequately treated wastes.

5. Suggest a program to eliminate storm flows and illegal connections to the sanitary sewers.

6. Recommend staffing of the system with sufficient numbers of trained personnel.

7. Suggest an inspection program for remote pumping stations.

8. Provide an alarm system for all remote pumping stations and at critical manholes for flood flows and gas.

9. Provide recommendations on accepting discharges from septic tank trucks.

10. Outline State monthly reporting requirements for pump station failures.

11. Ensure adequate laboratory facilities and personnel are provided to detect and monitor emergencies affecting effluent characteristics.

12. List required emergency equipment for response to emergencies involving chlorine gas.

13. Recommend a system for recording on-the-job injuries with emphasis on prevention measures.

14. List all safety equipment required (safety harness, devices to measure flammability of an atmosphere, and devices to measure oxygen in an atmosphere).

15. Set up a first aid training program for facility personnel and recommend type and number of industrial first aid kits to be maintained.

16. Recommend a procedure to insure all personnel receive tetanus toxoid inoculations and typhoid vaccine inoculations on a regular basis.

17. Outline a drill schedule for proper use of emergency breathing equipment.

18. Give preventive maintenance schedule for all emergency alarm systems.

19. Develop a list of industrial process chemicals that might enter the treatment system.

20. Recommend a list of downstream and upstream water users be prepared. (Water intakes, recreation areas, shellfish beds, and other waste discharges.)

21. Discuss problems that will exist upon failure or shutdown of major treatment system components with respect to effluent quality, effect on receiving stream and potential health hazard.

22. Outline corrective maintenance procedures to be employed to eliminate or minimize by-passing of treatment units.

23. Recommend coordination between the treatment system emergency response program and local civil defense activities.

24. State the potential for various natural disasters in the area where the treatment system is located.

25. Suggest mutual aid agreement alternatives and recommend a standard mutual aid agreement form.

26. Prepare an emergency equipment inventory for the treatment system.

27. Suggest the treatment system prepare a list of key personnel at local utility companies and request the local telephone company to give treatment system calls priority during a disaster.

28. Outline auxiliary personnel requirements.

29. Recommend a system for receipt of emergency reports on a 24 hour a day, 7 days a week basis.

30. Develop an emergency response program organization chart.

31. Provide guidelines for an emergency response center (location, facilities, and staffing).

32. Prepare treatment process flow diagrams for use in emergencies.

33. Prepare diagrams showing how emergency reports are received and relayed to appropriate personnel.

34. Provide owner with sample vulnerability worksheets so he may continually upgrade his emergency response program.

## OBJECTIVES

The Emergency Operating and Response Program's objectives should be listed in this section. The objectives of an Emergency Operating and Response Program include:

1. Eliminate or minimize adverse effects from emergency situations affecting the treatment system.

2. Develop procedures for properly responding to emergencies.

3. Provide instruction for system personnel to ensure they understand their responsibilities during emergency situations.

4. Provide inventories of available emergency equipment and outline existing mutual aid agreements and contracts with outside organizations for specialized assistance.

## VULNERABILITY ANALYSIS

The persons preparing an O & M Manual should perform a study to determine the potential for natural disaster, strikes and civil disorder in the area where the municipal wastewater treatment system is located. The following natural disasters should be investigated:

1. River floods
2. Tornadoes and windstorms
3. Hurricanes and storm surges, lightning
4. Forest and grass fires
5. Earthquakes
6. Landslides
7. Tsunami, (Tidal wave)
8. Volcanoes
9. Frosts, freezes and sleet storms
10. Droughts and low stream flows in receiving stream

This study will result in a priority list to use in performing the various system vulnerability analyses. For example, in areas that have a history of frequent hurricanes, the treatment system should be prepared to continue operation under the emergency conditions imposed on that system by a hurricane.

A vulnerability analysis of the system is an estimation of the degree to which the system is adversely affected, in relation to the function it must perform by an emergency condition.

The following steps should be followed in making a vulnerability analysis:

1. List components of treatment system.

2. Select emergency condition to be investigated.

3. Estimate effects of emergency condition on each component of system, use vulnerability worksheet.

4. Estimate treatment system's ability to perform its intended function during the emergency.

5. If system fails to perform, identify key system components responsible for the failure.

A vulnerability analysis worksheet is shown in Figure No. 14.

The results of the system vulnerability analysis should be discussed in this section of the manual. These results will include a list of the most vulnerable components of the treatment system.

METHODS TO REDUCE SYSTEM VULNERABILITY

A discussion of methods to reduce a treatment system's vulnerability should be provided. The Emergency Operating and Response Program chapter of the Manual should indicate priorities for repair of the system and alternate provisions in case of light or severe damage. The following methods can be employed to reduce the system's vulnerability:

1. An optimum preventive maintenance and testing program.

2. Duplication and separation of vital works.

3. Minimizing dependence on power and pumping.

4. Provision for more than one power source and/or transmission line.

5. Flexibility in operation of treatment works.

6. Maintenance of adequate chemical supplies.

## VULNERABILITY ANALYSIS WORKSHEET

TREATMENT SYSTEM: ____________________________________________

ASSUMED EMERGENCY: ____________________________________________

DESCRIPTION OF EMERGENCY: ______________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

| SYSTEM COMPONENT | EFFECTS OF EMERGENCY | PREVENTION RECOMMENDATIONS |
|---|---|---|
| | TYPE AND EXTENT | |
| Collection Lines | | |
| Pumping Stations | | |

FIGURE NO. 14. VULNERABILITY ANALYSIS WORKSHEET

# VULNERABILITY ANALYSIS WORKSHEET

| SYSTEM COMPONENT | EFFECTS OF EMERGENCY TYPE AND EXTENT | PREVENTION RECOMMENDATIONS |
|---|---|---|
| PRETREATMENT | | |
| CLARIFICATION | | |
| SECONDARY UNITS | | |

FIGURE NO.14 (CONTINUED)

## VULNERABILITY ANALYSIS WORKSHEET

| SYSTEM COMPONENT | EFFECTS OF EMERGENCY<br>TYPE & EXTENT | PREVENTION RECOMMENDATIONS |
|---|---|---|
| SLUDGE HANDLING | | |
| ADVANCED TREATMENT | | |
| POWER SUPPLY | | |

FIGURE NO. 14 (CONTINUED)

## VULNERABILITY ANALYSIS WORKSHEET

| SYSTEM COMPONENT | EFFECTS OF EMERGENCY<br>TYPE AND EXTENT | PREVENTION RECOMMENDATIONS |
|---|---|---|
| COMMUNICATIONS | | |
| PERSONNEL | | |

DATE:____________________ ANALYST:____________________

FIGURE NO. 14 (CONTINUED)

7. Provision of dual power sources, on-site storage of fuel and auxiliary power units, remote and/or automated controls, and ready conversion of automatic controls to manual operation.

8. Provision of portable pumps with fuel-operated units.

9. Provision at major pumping stations of more than one incoming and discharge pipeline.

10. Training of regular and auxiliary personnel in emergency operations and procedures. Training should be a combination of classroom instruction and on-the-job training.

11. Conducting emergency operations exercises periodically.

12. Provide proper tools in adequate supply and in the proper location. A tool and work room or shop is a necessity and should be in proportion to the plant size.

## MUTUAL AID AGREEMENTS

A list of mutual aid agreement alternatives should be given. The following is a partial list of organizations to be considered:

1. Other community divisions
2. Consulting engineers for the facility
3. Industrial firms
4. Construction companies
5. Electric, gas and telephone utilities
6. Fire and police departments
7. Civil defense organization
8. Health department

Figure No. 15 is a sample mutual aid agreement form.

## SAMPLE

## MUTUAL-AID AGREEMENT*

EMERGENCY SITUATIONS COULD ARISE IN A MUNICIPALITY'S WASTEWATER TREATMENT SYSTEM THAT WOULD REQUIRE ASSISTANCE FROM AN ADJOINING MUNICIPALITY TO RESTORE NORMAL OPERATION.

IF AN EMERGENCY SITUATION ARISES IN ______________________ (City) OR ______________ (City) THE OFFICIALS IN BOTH MUNICIPALITIES AGREE TO SUPPORT EACH OTHER DURING THE EMERGENCY.

EACH CITY HAS A CONTINGENCY PLAN FOR RESPONSE TO EMERGENCIES AFFECTING ITS WASTEWATER TREATMENT SYSTEM. THE ______________ (City) AGREES TO SUPPORT ______________ (City) IN THE FOLLOWING AREAS: ______________ (Firefighting, ______________________________ Rescue Crews, Communications, Portable Chlorination, Operational/ ______________________________ Maintenance, Personnel, etc.) ______________________________

______________________________ TO THE EXTENT POSSIBLE UPON REQUEST INITIATED BY:

| | |
|---|---|
| ______________ | ______________ |
| Name | Name |
| ______________ | ______________ |
| Title | Title |
| ______________ | ______________ |
| City | City |

PERSONNEL RESPONDING TO THE REQUESTS FOR ASSISTANCE UNDER THIS AGREEMENT WILL REMAIN UNDER THE CONTROL OF THE CITY PROVIDING THEM.

| | |
|---|---|
| ______________ | ______________ |
| Signed | Signed |
| ______________ | ______________ |
| Name | Name |
| ______________ | ______________ |
| Title | Title |
| ______________ | ______________ |
| City | City |

*Similar to format suggested by Planning Section, Virginia Office of Civil Defense.

FIGURE NO. 15 SAMPLE MUTUAL-AID AGREEMENT FORMAT

## SAMPLE MUTUAL AID AGREEMENTS/CONTRACTS SHEET

| NAME | DESCRIPTION OF ASSISTANCE | COORDINATION INFORMATION |
|---|---|---|
| Public Works Department | Department of Parks maintains 1,000 feet of 6 inch quick coupling aluminum pipe that is available to assist treatment system during emergencies. | To obtain pipe contact Dept. of Parks (Phone) during normal working hours or call city switchboard (Phone) after normal working hours. |
| City Water Department | Water Department maintains 2 portable chlorinators which can be used for emergencies within the wastewater treatment system. | Contact Water Department Supt. (Phone) or operator on duty at main filter plant (Phone). |
| ABC Construction Company | 4 tractor mounted back-hoes are available on a 24-hour basis. | Contact company main office (Phone) or after hours call John Doe, Equipment foreman (Phone) |
| ACME Welding Co. | Machine shop facilities and a portable welding machine are available on a 24-hour basis. | Call: (Phone) Office<br>(Phone) Home<br>(Phone) Home |

FIGURE NO. 16. SAMPLE MUTUAL AID AGREEMENTS/CONTRACTS SHEET

## EMERGENCY EQUIPMENT INVENTORY

An inventory should be made of equipment, materials and chemicals that are available within the treatment system. A sample wastewater treatment system emergency inventory worksheet is shown in Figure No. 17. Using this inventory and the results of the system vulnerability analysis any additional emergency equipment/supplies required may be purchased and stockpiled and/or arrangements made to obtain these items through mutual aid agreements or outside contracts. A sample emergency inventory sheet is shown in Figure No. 18. Similar sheets should be prepared for the treatment system at hand and included in this section of the manual.

## PRESERVING TREATMENT SYSTEM RECORDS

A program should be recommended for the protection of essential records, maps and inventories. It is especially important that maintenance crews and service vehicles be provided with maps and current records showing location and condition of collection lines. Full size copies of maps and other detail sheets should be made each year and kept in a vault that is not subject to flooding. Copies of the layouts of important pumping installations can also be kept here. These items are available for immediate use and can be reproduced as required. These records are readable and do not have to be processed by any further mechanical steps.

## INDUSTRIAL WASTE INVENTORY/MONITORING SYSTEM

An inventory should be made of all industrial contributors to the municipal treatment system. Each industry should be located on a collection system map and a list of the potential hazardous spill materials present prepared.

The names and phone numbers of key personnel with each industry should also be listed. Consideration should be given to installing industrial waste monitoring equipment in the sewer network at critical locations. A sample industrial waste inventory form is shown in Figure No. 19. Similar information for all industrial contributors should be provided in this section of the manual.

## WASTEWATER TREATMENT SYSTEM
## EMERGENCY INVENTORY

SYSTEM: ______________________________________________

PREPARED BY: ______________________________ DATE: ______________
(Signature)

DUPLICATE EQUIPMENT IN STOCK

| DESCRIPTION | MAKE | SIZE | TYPE | VOLTAGE | HP | CAPACITY | NO. |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

PARTS & COMPONENTS IN STOCK

| DESCRIPTION | SIZE | NO. | APPLICATION IN SYSTEM |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

FIGURE NO. 17 SAMPLE INVENTORY WORKSHEET

EMERGENCY EQUIPMENT & REPAIR TOOLS

| DESCRIPTION | NO. | APPLICATION IN SYSTEM |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| PIPE | SIZE | | | | | |
| | TYPE | | | | | |
| | LENGTH | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| AVERAGE CHEMICAL STOCK | TYPE | | | | |
| | FORM | | | | |
| | QUANTITY | | | | |

COMMUNICATIONS EQUIPMENT

| DESCRIPTION | LOCATION |
|---|---|
| | |
| | |
| | |
| | |

MAPS AND FACILITY LAYOUT DETAILS

| | |
|---|---|
| | |
| | |
| | |
| | |
| | |

FIGURE NO. 17 (CONTINUED)

OFFICIAL AUTHORIZING
INVENTORY

EMERGENCY INVENTORY

EQUIPMENT

| LOCATION | PUMPS | PIPE | CHLORINATORS | GENERATORS | HEAVY EQUIPMENT | COMMUNICATIONS | MISC. | CHEMICALS | PERSONNEL |
|---|---|---|---|---|---|---|---|---|---|
| (NAME OF MUNICIPALITY, SANITARY DIST. OR INDUSTRY) | TWO PORTABLE GASOLINE-POWERED 6" PUMPS | 600' OF 4" LIGHTWEIGHT QUICK-COUPLING ALUMINUM PIPE | | | TWO DUMP TRUCKS 5 CU. YD. CAPACITY | | | | TWO EXPERIENCED LABORATORY TECHNICIANS |
| NAME | | | ONE MOBILE CHLORINATOR, 300 LBS. PER 24-HR. CAPACITY | | | | ONE, AIR COMPRESSOR, 125 CFM, 100 PSI | | |
| NAME | | | | | ONE 35-TON CAPACITY MOBILE CRANE | | | | ONE EXPERIENCED INSTRUMENT TECHNICIAN |
| NAME | | | TWO-40 KW, 110/208 VOLT GASOLINE DRIVEN ELECTRIC GENERATOR SETS | | | | | FIFTY 100 LB. BAGS OF LIME | |
| NAME | | | | | | | ONE, PORTABLE ARC WELDING MACHINE | | |

FIGURE NO. 18 SAMPLE EMERGENCY INVENTORY SHEET

INDUSTRIAL WASTE INVENTORY*

| Name & Location | Industrial Waste Description/ Pretreatment Provided | Key Personnel |
|---|---|---|
| Industries should be in alphabetical order. Location should include manhole where industrial waste enters municipal system. | List waste by common name, chemical nomenclature, and trade name if applicable. Also list any other hazardous materials on hand that can potentially enter municipal treatment system and give neutralizing agents if applicable. Describe pretreatment system. | Give names, titles and phone numbers of all key personnel. At least one number should be designated as a 24 hour a day number. |
|  | SAMPLE |  |
| Acme Mfg. Co. Industrial waste is discharged into manhole at intersection of Main St. and Church St. | Waste is acidic, pH below 4.0 due to presence of sulfuric acid, $H_2SO_4$. There exists potential for a spill of concentrated sulferic acid which can be neutralized with strong basic materials such as lime. No pretreatment is provided. | John Doe<br>Plant Manager<br>(Phone)<br>Bill Smith<br>Maintenance Supt.<br>(Phone)<br>Plant Security Office<br>(Phone)**<br>**24-hour number |

*Inventory should be cross-referenced using common names of chemicals/materials found under Industrial Waste Description.

FIGURE NO. 19 SAMPLE: INDUSTRIAL WASTE INVENTORY

## COORDINATING INSTRUCTIONS FOR LOCAL POLICE AND FIRE DEPARTMENTS

The treatment system's Emergency Operating and Response Program should be coordinated with the local police and fire departments. These coordinating instructions should be outlined in this section of the manual. Consideration should be given to the items in the following checklists:

Police Department Checklist:

1. Critique existing treatment system security measures.
2. Make routine checks of treatment facility and pumping stations.
3. Notify treatment plant in the event of a street spill of hazardous materials.
4. Be prepared to assist during emergencies within the treatment system.

Fire Department Checklist:

1. Routinely check fire fighting equipment within the facility and inspect facility for potential fire hazards.
2. Provide first aid instruction to treatment system personnel.
3. Coordinate with treatment system personnel on safety precautions to be used with chlorine gas.

## RESPONSIBILITIES OF TREATMENT SYSTEM PERSONNEL

The municipal wastewater treatment system director should have overall responsibility for the emergency program. The wastewater treatment superintendent and the collection system superintendent are responsible for implementing the emergency program within their respective areas and they report directly to the treatment system director. If the treatment system is organized so that a single individual is in charge of the treatment facilities and the collection system, then this facility superintendent has overall responsibility for the emergency program.

The wastewater treatment system management should be familiar with the Disaster Relief Act of 1970 (Public Law 91-606). Management should be familiar with the Office of Emergency Preparedness Circular 4000.5C, Manual for Applications, Federal Disaster Assistance Program. If management is familiar with the procedures described in these documents, it will ensure that Federal assistance is received in a prompt and efficient manner.

Treatment system personnel should be given identification cards with their picture attached. These cards will permit them to gain access to areas that may be restricted during an emergency.

All regular and auxiliary wastewater treatment system personnel should be issued an emergency response card.

Each individual should familiarize himself with the data contained on his card. This information outlines what tasks and responsibilities he has in given emergency situations.

Figure No. 20 is a sample Emergency Response Card.

Persons preparing the O & M Manual should outline the responsibilities of the system's personnel and outline procedures for preparing emergency response cards.

SAMPLE

EMERGENCY RESPONSE CARD*

( NAME OF CITY ) WASTEWATER TREATMENT SYSTEM
EMERGENCY RESPONSE CARD

NAME: John (FIRST) J. (MIDDLE) Jones (LAST)

NORMAL DUTY ASSIGNMENT: Mechanics Helper

| EMERGENCY SITUATION: | EMERGENCY ASSIGNMENT: |
|---|---|
| Pump Station Power Failure | Report to Maintenance Shop and stand by to serve on emergency crew for portable pumps (Give Name of Crew Chief) |
| Mechanical Equipment Failure | Report to Maintenance Foreman (Give Name) in treatment plant main control building for assignment. |
| Chlorine Gas Leak | Assist senior mechanic to correct problem. Pick up gas masks and chlorine cylinder repair kit located in main control building. |
| Natural Disaster or Civil Disorder | Try to contact Emergency Response Center to determine if conditions require you to report to maintenance shop. If you are told to report for duty, your supervisor is (Give Name). |

*Similar to cards in Virginia's "NATURAL DISASTER ASSISTANCE RELIEF PLAN"

FIGURE NO. 20 SAMPLE EMERGENCY RESPONSE CARD

## EMERGENCY RESPONSE CENTER

A study should be made to determine the location, facilities, and staffing of the treatment system's Emergency Response Center and alternate center.

In most cases, the Emergency Response Center will be located in the main building of the treatment facility. The senior operator on duty should be responsible for the center and all individuals who perform this function must be adequately trained and thoroughly familiar with the Emergency Operating and Response Program.

A main control panel at the emergency response center should contain the pumping station high water/power failure alarms and the high water alarms for critical manhole locations. Upon receipt of an alarm, the operator on duty should dispatch the on-call maintenance crew to the scene of the alarm. A current telephone call list should be maintained at the emergency center as well as collection system maps and treatment facility piping and wiring diagrams.

When emergency condition notices are received by telephone at the emergency response center, the operator on duty should have a procedure to ensure all pertinent information surrounding the emergency is accurately recorded.

In this section of the manual the location, layout and operating procedures for the emergency response center should be given.

## AUXILIARY PERSONNEL REQUIREMENTS

Based on the results of the system vulnerability analysis, the person preparing the manual should make recommendations on auxiliary personnel needs.

Conditions can occur for which the treatment system is not adequately staffed or when staff members are not able to reach their assigned emergency positions. Auxiliary personnel obtained from other departments within the local government or through mutual aid agreements should be trained as back-ups for the regular staff. Procedures for alerting these auxiliary personnel should be clearly outlined and provisions for rehearsals to keep these personnel up to date on emergency operating procedures.

Process diagrams should be developed to show how units may be by-passed during emergencies and/or help pinpoint problem areas when emergencies arise. These diagrams would show all units within the facility, valve arrangements and settings for achieving specific conditions and splitter box locations with their capabilities shown.

A procedure should be established for the treatment system owner to critique responses to emergency situations. The areas that should be critiqued include:

1. Performance of automatic alarm system.
2. Performance of emergency standby equipment.
3. Response time reasonable.
4. Personnel training adequate.
5. Mutual aid agreements and/or contracted assistance adequate.
6. Emergency equipment/supplies adequate.
7. Treatment process flexibility.
8. Adequacy of emergency procedures.

# CHECKLIST*

## EMERGENCY OPERATING AND RESPONSE PLAN
## CHAPTER OF O & M MANUAL

Perform a study to determine the potential for natural disaster in the area where the municipal wastewater treatment system is located. This study should result in an estimate of the severities and frequencies of occurrence for each natural disaster investigated. From the severity/frequency estimate a priority list can be established for use in performing the various system vulnerability analyses.

Perform a vulnerability analysis of the treatment system. Compare the analyses results and identify the key-most vulnerable components of the system. List these key components and indicate priorities for repair. Suggest techniques to reduce vulnerability of key components.

Inventory the emergency equipment, materials, and chemicals available within the treatment system. This inventory should be printed in the emergency response plan chapter of the O & M Manual. Suggest any additional equipment/supplies that should be purchased and maintained.

Based on the disaster study, vulnerability analyses, and emergency inventory, prepare a list of potential mutual aid agreements. This portion of the plan could contain a sample mutual aid agreement form.

Develop a program for the protection of essential records, maps and inventories. A list of the documents to be protected should be prepared.

Prepare an inventory of all industrial contributors to the municipal treatment system. Locate each industrial discharge on a map of the collection system. Suggest monitoring equipment in collection lines if necessary. List potential hazardous materials and neutralizing chemicals. Prepare a list of key personnel at each industry. Suggest mechanism for industries to report accidental spills to treatment plant.

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* This checklist is provided to assist persons preparing the Emergency Operating and Response Program Chapter of an O & M Manual.

Establish a program for local fire and police departments to periodically review treatment system for adequacy of fire prevention methods and security measures. These agencies should also be made aware of any potential chlorine gas emergencies.

Prepare emergency response cards for all treatment system personnel. These cards outline each individual's emergency condition duties. Sample cards should be included in the O & M Manual.

Designate the area that is to serve as the emergency response center. List the equipment and staffing requirements for this center.

An important area to be covered in the emergency response plan chapter of the manual is the procedure to be followed when reporting damages to the treatment system's insurance company.

Develop the requirements for auxiliary personnel to assist when conditions exceed capability of existing staff or staff members are unable to reach their assigned emergency positions.

Prepare treatment process diagrams to show how units may be bypassed during emergencies and to assist in locating problem areas during emergencies.

Develop a program to allow the treatment system owner to critique the emergency response actions of his personnel.

Prepare an emergency condition matrix. This matrix should list likely emergency conditions and give response plan actions and prevention recommendations for that particular system.

Establish a program for training personnel in emergency operating procedures.

Prepare a list of local contractors and repair services. This list can be used in selecting firms from which to request assistance during emergencies.

Coordinate with local utility companies. Determine the probability of power failures that would affect the treatment system. List key personnel at utility companies to be contacted during emergencies.

Describe the failsafe alarm system that is installed at the treatment plant and at remote pumping station.

Establish a plan to insure chlorination can be provided to any potential spill of raw or inadequately treated municipal wastewater.

Set up a program for placing emergency standby equipment into service periodically.

Coordinate with local water utility and establish priorities for repairing lines and facilities after a disaster.

During a major emergency the water treatment plant and distribution system may suffer major damage resulting in very little flow of wastewater reaching the treatment facility. For this reason, careful coordination with the local water supply system is necessary as it may well be that the waterworks restoration has priority over the wastewater treatment plant.

# SECTION XVI

## O & M MANUAL CHAPTER X: SAFETY*

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* The format suggested for the table of contents page for the Safety Chapter of an O & M Manual is similar, except for the Discussion portion, to the format given for this section of the Considerations Manual.

## DISCUSSION

The safety hazards associated with municipal wastewater treatment systems are many and varied. They run from the dangers of chlorine handling to the potential for contracting waterborne diseases. Treatment personnel should be made aware of all these hazards. They should be protected from these hazards to the greatest extent possible and should receive proper first aid training in the event an accident does occur. A treatment system with a poor safety record will generally be providing marginal wastewater treatment as well. This chapter of an O & M Manual can play an important part in launching a treatment system into a sound safety program.

The primary purpose of this chapter of an O & M Manual is to help prevent personal injury to the treatment system staff. To fulfill this stated purpose the safety portion of the manual should inform personnel of potential hazards, preventive measures, and emergency procedures. Emphasis should be placed on the specific hazards within the treatment system under consideration.

The treatment system management must assume full responsibility for the safety program within their system. For a discussion of management's responsibility for safety, the EPA has a Technical Bulletin under development entitled "Safety in the Operation and Maintenance of Wastewater Treatment Works", Contract No. 68-01-0324.

The overall dangers of accident are much the same whether in sewers, pumping stations or treatment facilities. These hazards may be classified into the following broad categories:

- Physical injuries
- Bacterial infections
- Gas (explosive or noxious vapors) and oxygen deficiency
- Radiological hazards

The telephone numbers of several local physicians, the nearest hospital, police and fire departments, ambulance services and rescue squad should be posted at each phone in the treatment system. The telephone number of the chlorine equipment manufacturer and local supplier should be readily available in the event of a chlorine emergency.

## GENERAL

An important aspect of plant safety is the prompt reporting of personnel injuries to the treatment system's insurance company. Details on reporting accidents should be outlined and any other pertinent insurance information discussed in this section of the manual.

The sections suggested for an O & M Manual's Safety Chapter are listed below with references to assist manual preparers.

## SEWERS

References for persons preparing an O & M Manual:

WPCF MOP No. 1, Safety in Wastewater Works, Chapter 2.

WPCF MOP No. 7, Sewer Maintenance, Chapter 9.

## ELECTRICAL HAZARDS

References for persons preparing an O & M Manual:

EPA Technical Bulletin entitled, Safety in The Operation and Maintenance of Wastewater Treatment Works, Contract No. 68-01-0324, Section 4.5.

Operation of Wastewater Treatment Plants, A Field Study Training Program, Environmental Protection Agency, Technical Training Grant No. 5TT1-WP-16-03, Chapter 12.17.

## MECHANICAL EQUIPMENT HAZARDS

References for persons preparing an O & M Manual:

EPA technical Bulletin entitled, *Safety in The Operation and Maintenance of Wastewater Treatment Works*, Contract No. 68-01-0324, Section 4.17.

*Operation of Wastewater Treatment Plants*, A Field Study Training Program, Environmental Protection Agency, Technical Training Grant No. 5TT1-WP-16-03, Chapter 12.21.

## EXPLOSION AND FIRE HAZARDS

References for persons preparing an O & M Manual:

WPCF MOP No. 1, *Safety in Wastewater Works*, Chapter 4.

EPA Technical Bulletin entitled *Safety in The Operation and Maintenance of Wastewater Treatment Works*, Contract No. 68-01-0324, Section 4.6 through 4.10.

## BACTERIAL INFECTION (HEALTH HAZARDS)

References for persons preparing an O & M Manual:

EPA Technical Bulletin entitled *Safety in The Operation and Maintenance of Wastewater Treatment Works*, Contract No. 68-01-0324, Section 4.14.

*Manual of Instruction For Sewage Treatment Plant Operators*, New York State Health Department, Chapter 14.

## CHLORINE HAZARDS

References for persons preparing an O & M Manual:

*Chlorine Manual*, Chlorine Institute, Sections 1, 3, 6 and 7.

AWWA, Water Quality and Treatment, 3rd Edition, Chapter 5.

Basic Gas Chlorination Manual, Ontario Water Resources Commission.

### OXYGEN DEFICIENCY AND NOXIOUS GASES

References for persons preparing an O & M Manual:

WPCF MOP No. 1, Safety in Wastewater Works, Chapter 4.

Operation of Wastewater Treatment Plants, a Field Study Training Program, Environmental Protection Agency, Technical Training Grant No. 5TT1-WP-16-03, Sections 12.12 and 12.13.

### LABORATORY HAZARDS

References for persons preparing an O & M Manual:

WPCF Publication No. 18, Simplified Laboratory Procedures For Wastewater Examination, Section 1.7.

WPCF MOP No. 1, Safety in Wastewater Works, Chapter 8.

### SAFETY EQUIPMENT

References for persons preparing an O & M Manual:

EPA Technical Bulletin entitled Safety in the Operation and Maintenance of Wastewater Treatment Works, Contract No. 68-01-0324, Section 2.15.

WPCF MOP No. 1, Safety in Wastewater Works, Chapter 5.

## PROCESS CHEMICAL HANDLING

References for persons preparing an O & M Manual:

AWWA, _Water Quality and Treatment_, 3rd Edition, Chapter 17.

EPA Technical Bulletin entitled _Safety in The Operation and Maintenance of Wastewater Treatment Works_, Contract No. 68-01-0324, Section 4.4.

## SAFETY REFERENCES

This section of the O & M Manual should contain a list of safety references of interest to operating personnel.

_EPA Technical Bulletin_*

Safety in the Operation and Maintenance of Wastewater Treatment Works, Contract No. 68-01-0324

*NOTE: This bulletin is in preparation at this time.

_Water Pollution Control Federation_

| | |
|---|---|
| MOP No. 1 | Safety in Wastewater Works |
| MOP No. 4 | Chlorination of Wastewater and Industrial Wastes |
| MOP No. 7 | Sewer Maintenance |
| MOP No. 11 | Operation of Wastewater Treatment Plants |
| MOP No. 18 | Simplified Laboratory Procedures for Wastewater Examination |

State of New York, Health Education Service

Manual of Instruction for Sewage Treatment Plant Operators

Texas Water Utilities Association

Manual of Wastewater Operations

Ontario Water Resources Commission

Basic Gas Chlorination Manual

Chlorine Institute

Chlorine Manual

American Water Works Association

Water Quality & Treatment, 3rd Edition

Figure No. 21 is a sample accident report form of the type that could be used at a municipal wastewater facility. A copy of the accident report form recommended for the treatment system should be included in the O & M Manual unless the treatment system's insurance company has a standard accident report form. If a standard form exists it should be properly referenced in the O & M Manual.

ACCIDENT REPORT FORM

DATE ____________________

INSURED
PERSON ________________________________________ ________________________
(NAME) (JOB TITLE)

DATE OF INJURY ________ ________ ________ AM PM
(DAY) (MONTH) (TIME)

PLACE ACCIDENT OCCURRED ____________________________________________

DESCRIPTION OF ACCIDENT ____________________________________________

CORRECTIVE ACTION TAKEN ____________________________________________

INSURANCE COMPANY ____________________________________________

TIME LOST

| DATE | HOURS |
|---|---|
| ____ | ____ |
| ____ | ____ |
| ____ | ____ |
| ____ | ____ |

PERSON MAKING REPORT ____________________
(NAME)

REMARKS, DIAGRAM, RECOMMENDATIONS, ETC.:

FIGURE NO. 21 SAMPLE ACCIDENT REPORT FORM

# SECTION XVII

## O & M MANUAL CHAPTER XI: UTILITIES*

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* NOTE: This section's table of contents format can be used for the table of contents page for the Utilities Chapter of an O & M Manual.

## GENERAL

The utilities serving a municipal wastewater treatment facility play a major role in the proper operation of the facility. Frequent or prolonged interruptions of service can have significant effects, even on systems that have some form of standby or alternate service. This section of an O & M Manual should be prepared emphasizing that all treatment system personnel have an interest in the reliability of the utilities they use. The sizes and capacities of the lines serving the facility are also of interest. The identification of contact men within each utility company is essential for proper response to routine and emergency operations.

## ELECTRICAL

This section of the O & M Manual should give the name of the electrical utility company supplying power to the treatment system. The voltage of the electrical service adjacent to the facility should be given as well as the reduced voltage entering the plant. If standby power is provided from a second line, this system should be completely described. The standby power capacity furnished may have been substantially less than that of normal power requirements if the local water utilities reliability is directly affected by power outages. Reductions in available water will directly affect wastewater volumes. If this condition exists, it should be described here.

A detailed description of the power source should be included in the Electrical System Chapter of the O & M Manual.

A brief statement on the reliability of electrical service should be made. This statement should be based on studies of past performance and discussions with utility personnel. The discussion should include clearly defined break points in responsibility for service facilities between the utility company and the wastewater facility.

Coordination with the electrical utility company is essential during power failures and other electrical problems. Key personnel within the utility company should be designated as contact men and provisions made for reaching them during emergencies. Advanced arrangements should include suitable priority for restoration of normal service following areawide power loss.

## TELEPHONE

The telephone communications system within the treatment system should be discussed. Many alarm systems used in wastewater treatment operations utilize telephone lines. These alarm systems should be described and a statement made as to "failsafe" capabilities. Contact men within the telephone company should be designated for routine and emergency operations. Arrangements with the telephone company should ensure priority to wastewater facility calls during emergencies that limit telephone service.

## NATURAL GAS

The natural gas utility company serving the treatment facility should be named and a description of the service given. Contact men within the company should be designated and a statement of reliability made. The cubic feet per hour and the normal operating pressure should be given for the gas lines servicing the facility.

## WATER

The name of the water utility providing water to the treatment system should be given. The size waterline serving the facility and its operating pressure should be given. If a pressure-reducing valve is used, its function and location should be mentioned. If any nonpotable waterlines are connected to the potable system using backflow preventer valves, they should be discussed. Additional information on cross-connection prevention should be outlined. On site fire service water supply should also be discussed.

Contact men within the water utility company should be designated and provisions made for reaching them during emergencies. A statement of reliability of water supply should be included.

## FUEL OIL

If facilities or processes require fuel oil for heating purposes, the sources for this fuel should be listed. A schedule or method of ensuring adequate fuel supplies are on hand should be outlined. Capacities of fuel oil storage facilities at the treatment plant should be given.

The following is a sample of the Electrical portion of the Utilities Chapter of a typical O & M Manual:

## SAMPLE

### Electrical

Electrical power is provided to the main wastewater treatment plant by the ABC Power Company. A 12,500 volt line is adjacent to the facility and a transformer reduces the voltage to 480 volts for use at the plant. A standby source of power comes to the plant on a second line and originates on the East side of the city. Power company records show that only once in the past ten years has power been off from both sources at the same time. The power reliability records indicate excellent reliability can be expected. Maximum power outage in the past ten years has been 5½ hours. The break point for responsibility for electric service facilities between the power company and the wastewater plant owner is the main service disconnect.

The following individuals have been designated as contact men within the power company to respond to electrical emergencies at the treatment plant:

| Name | Title | Business Phone | Home Phone |
|---|---|---|---|
| John Jones | Foreman | 124-3333 | 123-4567 |
| Bill Smith | Foreman | 124-3333 | 123-8910 |
| 24 Hour Emergency Repair | | (124-3330) | |
| Owner's Contractor | | | |
| D. R. Brown | Electrical Contractor | 124-4444 | 123-2121 |

NOTE: Many wastewater treatment plants have overlapping utilities. For example, the fuel used for heating the plant's control building may be either fuel oil, sludge gas or natural gas. In these cases the O & M Manual Utilities Chapter should describe the alternate or overlapping utilities.

## SECTION XVIII

## O & M MANUAL CHAPTER XII: ELECTRICAL SYSTEM*

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* The format suggested for the table of contents page for the Electrical System Chapter of an O & M Manual is similar, except for the Discussion portion, to the format given for this section of the Considerations Manual.

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## DISCUSSION

In today's modern treatment plants, the electrical system has become the most important single factor affecting all processes. Practically all operations involve some type of electric motor to power a pump, sludge collector mechanism or aeration equipment. A facility's electrical system must be adequately described in this chapter of an O & M Manual if operating personnel are to successfully use the flexibility designed into their electrical systems.

The purpose of this chapter of the O & M Manual is to provide sufficiently detailed information on the treatment system's electrical system to insure efficient plant operation. The importance of a complete and accurate electrical system chapter cannot be overemphasized.

## GENERAL

Description of the electrical system should be accomplished by a combination of schematic diagrams, tables, manufacturer's descriptive literature, and manufacturer's and contractor's detailed shop drawings. These documents can be filed and properly indexed with the indexing system described in the O & M Manual. Also included should be notes by the Engineer indicating pertinent information.

## POWER SOURCE

The following information should be included in a description of the power source:

1. Name of electric utility company.

2. Characteristics (voltage, overhead or underground, etc.) of primary distribution line serving the plant.

3. Description of the main transformer(s) (ownership, voltage, phase, connection, capacity, type, impedance, taps, etc.) as well as the physical location.

4. Types, ratings, and settings of protective devices.

5. Value of the maximum available short-circuit current at point(s) of service from the electric utility company.

A properly noted one-line schematic diagram would be the best way to present most of the above information. Manufacturer's literature and shop drawings should supplement this diagram.

POWER DISTRIBUTION SYSTEM

As in the case of the power source, the power distribution system also would best be described by a properly noted one-line schematic diagram. This diagram or any written description should contain the following information:

1. Service entrance equipment description (location, type of equipment, load capacity, short-circuit interrupting capacity, calculated short-circuit duty, voltage rating, etc.).

2. All motor control centers, distribution switchgear assemblies, panelboards, or other major components of the electrical system should be described similar to (1.) above.

3. Also included should be tabulations of schedules of the components of the equipment in (1.) and (2.) above which indicate the power wiring from and the loads fed by such components.

Manufacturer's literature and shop drawings should be provided for each major component of equipment. Contractor's shop drawings should also be provided.

## CONTROL AND MONITORING SYSTEM

Process monitoring and control instrumentation should be described by appropriate schedules and tabulation indicating the type of controls and monitors, and the process equipment involved. Where involved sequences are present, schematic diagrams should be prepared.

Manufacturer's literature on specific components of control and monitoring equipment should be provided.

## ALTERNATE POWER SOURCE

The alternate power source should be described in the same detail as the primary power source previously discussed. If the alternate power system includes any duplicate power distribution equipment, this equipment should be described in the same detail as the power distribution system previously discussed.

# SECTION XIX

## O & M MANUAL: APPENDICES *

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* NOTE: The format for this section's table of contents is identical to the format suggested for the Appendix of an O & M Manual.

This section of an O & M Manual is used for including any additional or supplemental material not suitably included in the text of the manual. Certain appendix items may be too bulky or cumbersome to be bound in the manual itself. These items should be bound separately or folded and placed in plastic pouches in the Appendix of the Manual. Fold-out pages can be used effectively in some places.

Several of the appendix subject areas are interdependent and the depth of content of any one is substantially dependent on the content of the others. The subject areas involved are: Schematics, Valve Indices, As-Built Drawings, Approved Shop Drawings, Dimension Prints and Color Coding. The overriding guidelines to the detail that should be provided under each subject is that the total blend of these subjects, together with proper coordinating narration, quickly and clearly conveys to the operational staff necessary information on operational modes and related controls. Key valves and gates must be suitably identifiable both on the drawings and schematics and in place.

### Schematics

Basic flow diagrams, process flow sheets, bypass piping diagrams and hydraulic profiles are very useful in explaining and illustrating treatment plant operation. Generally these schematics are a part of the engineering drawings. They can be included in the manual text to illustrate a specific point. However, there will be cases where schematics are more logically placed in the manual's appendix. The individuals preparing an O & M Manual for a specific treatment system can best decide what schematics should be included in the appendix and in what form they should appear. A separate section of the manual's appendix has been designated for as-built drawings. Approved shop drawings and dimension prints each have a separate section in the appendix.

### Valve Indices

Having a complete list of the treatment system's primary valves will help ensure efficient and continuous facility operation. Valve indices are systems for identifying or locating valves and can be one, or a combination, of the following:

(a) A complete tabulation of principal valves, each separately numbered and identified as to type, location and function, with each to be suitably field tagged with a noncorrosive tag.

(b) A coding system for each type of valve (plug, gate, throttling, etc.) together with a prefix or suffix identifying its liquid content or process function (raw sludge, return sludge, etc.) and each valve coded on the construction drawings.

(c) A series of sketches for principal valves or clusters of valves and adjacent piping that are buried. The sketch permits immediate location by giving three lateral measurements to nearby permanent aboveground objects and usually includes a tabulation of key characteristics, e.g., size, make, type, year, direction, and turns to open, depth to top of stem, valve box size and marking, process control, etc.

Sample Forms

The operation and maintenance of any municipal wastewater treatment system involves the use of many forms such as daily operating logs, State monthly operating reports, equipment data cards, maintenance work orders and purchase orders for supplies and equipment. A sample of all forms to be used at the treatment facility should be included either in the manual text or appendix. Instructions for completing each form should be given.

## Chemicals Used in Plant

Any chemicals used in the treatment process should be listed. Safety precautions to be used when handling these chemicals should be outlined in the Safety Chapter of the O & M Manual. Storage considerations should be discussed. Chemical suppliers should be listed and an ordering schedule should be given to insure adequate quantities are on hand at all times. Capacities of dry chemical storage areas and liquid storage tanks at the facility should be described. Chemicals common to municipal wastewater treatment include lime, alum, ferric chloride, ferrous and ferric sulfate, chlorine, sulfuric acid, sulfur dioxide and polymers.

## Chemicals Used in Laboratory

A discussion of laboratory chemicals should be included in the Laboratory Testing Chapter of the O & M Manual. This section of the Appendix should list the lab chemicals by common name, chemical name and give the chemical formula. If any chemicals used in the lab are to be purchased in bulk quantities, they should be so designated. Suppliers' names and suggested quantities to be ordered should be given. The construction specifications usually contain similar information on lab chemicals and should be referenced to supplement the information in this section.

## Emergency Operating and Response Program

The Emergency Operating and Response Program Chapter of the O & M Manual should give a detailed description of the treatment system's plan for responding to emergencies. This section of the Appendix should be used for any supplementary material such as schematic diagrams and sample forms.

## Detailed Design Criteria

This section of the Appendix should give the design criteria for all unit operations and processes in the treatment system. Typical criteria includes approach velocity and allowable head loss for bar screens; estimate of cubic feet of screenings to be removed per million gallons of wastewater treated; comminutor capacities; grit chamber size and flow through velocity; estimate of cubic feet of grit to be removed per million gallons of wastewater treated; surface loading rates, detention time, weir loadings and unit dimensions should be given for sedimentation tanks; detention time and desired residual for chlorine contact tanks; food-to-microorganism ratio or mean cell residence time, air requirements, and tank dimensions for the activated sludge process; trickling filter dimensions, hydraulic loading, and recirculation capacities, loadings to sludge thickeners; digestion capacities, heat requirements, and chemicals required; both wastewater and sludge pumping criteria should be given; vacuum filter yield; sludge drying bed capacities; incineration heat requirements, and so forth.

### Equipment Suppliers

The equipment supplied to a new municipal wastewater treatment plant is generally not precisely known until the contractors have submitted their bids for the construction of the facility. However, the individuals preparing this section of an O & M Manual's Appendix can develop a relatively complete list of suppliers and up-date this portion of the manual after the actual equipment suppliers have been confirmed. The list of suppliers should include their name, equipment furnished and local representative.

### Manufacturers' Manuals

The operating and maintenance manual furnished with each piece of equipment should be kept as an appendix to the treatment system's O & M Manual, and may be bound separately. These manuals will be valuable when performing maintenance on equipment and when ordering parts, components or new items. The indexing system used with the Manufacturers' Manuals should be outlined. The system could be numerical and patterned after the equipment numbering system.

### Sources for Service and Parts

Local repair services and supply houses should be canvassed. A list of potential sources for the types of repairs and equipment parts required by the treatment facility should be made. Such a list might include a meter repair service and plumbing supply wholesaler.

## As-Built Drawings

It is essential that the personnel responsible for operating and maintaining a municipal wastewater treatment facility be furnished with a complete and accurate set of as-built engineering drawings. These as-built drawings should be furnished sufficiently in advance of start-up to permit proper training of operating and maintenance personnel. These drawings help during repair work, modifications and/or plant enlargements. Proper indexing is essential to use these drawings and an indexing system should be given in the manual.

## Approved Shop Drawings

Just as a complete and accurate set of as-built drawings is important, so are the approved shop drawings. These shop drawings give the detailed description of specialty items within the facility and of built-in or concealed items. They show such things as clarifier sludge removal mechanisms and anaerobic digester mixing mechanisms. Proper indexing is essential to use these drawings and an indexing system should be given in the manual.

## Dimension Prints

Dimension prints give the actual relationship between installed equipment and adjacent walls and openings. These prints are especially helpful to evaluate modifications or equipment replacements, and permit important preliminary actions to be undertaken without shutdown.

## Construction Photos

Photographs should be taken throughout the construction phase of the project. Special attention should be given to underground or other concealed piping and diversion structures. These photos can be valuable during emergencies and in everyday plant operational difficulties. All pictures should be labeled and dated. A system for indexing and filing the photos should be outlined.

### Warranties and Bonds

All equipment within a treatment system should be under warranty for at least one year. Copies of these warranties together with roof bonds should be placed in the O & M Manual's Appendix. A performance bond guarantees the Contractor can fulfill his contractual obligation to the Owner of the system and usually remains in effect during the warranty period of one year. A copy of this bond should also be included in the Manual's Appendix.

### Copies of State Reporting Forms

Pertinent State forms not found in other sections of the Manual should be placed in the Appendix. Instructions for completing these forms should also be included. Typical State forms include monthly operating report, bypass report, chlorine failure report, and others applicable to the permit program.

### Copies of Federal Inspection Forms

A copy of EPA Form 7500-5 (4-72), Report on Operation and Maintenance of Wastewater Treatment Plant, should be included in the O & M Manual's Appendix. This will assist operational personnel in familiarizing themselves with the federal inspection criteria.

### Infiltration Controls

If there is an existing infiltration ordinance, a copy should be included in the O & M Manual's Appendix. If no ordinance exists, a suggested model ordinance could be included in this section.

### Industrial Waste Controls

If there is an existing industrial waste ordinance, a copy should be included in the O & M Manual's Appendix. If no ordinance exists, a suggested model ordinance could be included in this section. (See Water Pollution Control Federation, MOP #3, p. 24, 1968.)

### Piping Color Codes

The various piping systems should be color coded for safety purposes and to insure efficient operation. The coding system selected for use in the treatment system should be outlined in this section of the Appendix. This should be the standard color code for treatment works.

For additional information in piping color codes, refer to the Water Pollution Control Federation, MOP #17, "Paints & Protective Coatings", (1969) and EPA Technical Bulletin entitled (in preparation at this time) "Safety in The Design of Wastewater Treatment Works", Contract No. 68-01-0324.

### Painting

Keeping units and equipment painted with proper protective coatings is an important preventive maintenance function. This section of the Appendix should describe the various type of coatings to be used throughout the facility and give a suggested painting schedule. The manufacturer's trade name, and number and color should be specified. Comparable coatings by other manufacturers may sometimes be obtained when this information is known and the original material is not available.

For additional information on painting, refer to the Journal Water Pollution Control Federation, MOP #17, "Paints and Protective Coatings", (1969).

### References

Reference books, manuals and publications can be valuable tools to treatment system personnel. They may provide detailed laboratory test procedures or give hints on the proper operation of a biological process. The Appendix of the O & M Manual should provide a list of essential references recommended for immediate procurement and a second list giving references that may be obtained at a later date.

Several examples of certain Appendix items suggested for an O & M Manual have been included in the balance of this section. These examples are not intended to be rigid formats for their respective appendix items but only samples of the type information to be included in an O & M Manual The examples include:

Appendix Item Page

Detailed Design Criteria ..............................196

Construction Photos ..................................200

Federal Inspection Forms ..............................201

Painting .............................................207

References ...........................................209

# DETAILED DESIGN CRITERIA

Detailed design criteria should be included on the plant as a whole and for each individual unit. Design criteria should be stated for the initial conditions as well as for the design conditions, and any special considerations such as existing and future industrial waste flows should be included.

Example: Detailed Design Criteria:

| | Initial 1972 | Design, Year 1990 |
|---|---|---|
| Population | 4,000 | 10,000 |
| Quantity and Quality of Wastes | | |
| Per capita contributions | | |
| Sewered: | | |
| Average daily flow, gal./capita/day | 100 | 100 |
| 5-day BOD, lb/capita/day | 0.17 | 0.20 |
| Suspended solids, lb/capita/day | 0.20 | 0.22 |
| Industrial waste characteristics, mg/l, average | | |
| 5-day BOD | 200 | 300 |
| Suspended solids | 240 | 350 |
| Domestic flows, mgd, average | 0.40 | 1.00 |
| Industrial flows, mgd, average | 0.30 | 1.00 |
| Total flows (domestic plus industrial), mgd | | |
| Average | 0.70 | 2.00 |
| Sustained peak | 1.05 | 3.10 |
| Instantaneous peak | 1.40 | 4.00 |
| Minimum | 0.30 | 0.50 |
| BOD loadings, lb/day, average | | |
| Domestic | 680 | 2,000 |
| Industrial | 510 | 2,500 |
| Total | 1,190 | 4,500 |

|  | Initial 1972 | Design, Year 1990 |
|---|---|---|
| Suspended solids loadings, lb/day average |  |  |
| Domestic | 800 | 2,200 |
| Industrial | 600 | 2,921 |
| Total | 1,400 | 5,121 |
| Parshall Flume |  |  |
| No. of Units | 1 | 1 |
| Throat width, in. | 6 | 18 |
| Aerated Grit Chamber |  |  |
| No. of Units | 1 | 1 |
| Width, ft. | 10.0 | 10.0 |
| Length, ft. | 23.0 | 23.0 |
| Average water depth, ft. | 7.0 | 7.0 |
| Detention at average flow, minutes | 22.9 | 8.0 |
| Detention at instantaneous peak flow, minutes | 11.5 | 4.0 |
| No. of blowers | 2 | 2 |
| Unit blower capacity, cfm | 150 | 150 |
| Air cfm/lf. maximum | 6.5 | 6.5 |
| Method of cleaning | clamshell bucket and hoist | clamshell bucket and hoist |
| Comminutor and Bypass Screen |  |  |
| Comminutor: |  |  |
| No. of Units | 1 | 1 |
| Unit size, in. | 25 | 25 |
| Unit capacity, mgd | 7.9 | 7.9 |
| Screen: |  |  |
| No. of Units | 1 | 1 |
| Width of channel, ft. | 3.4 | 3.4 |
| Capacity, mgd | 7.9 | 7.9 |
| Method of cleaning | manual raking | manual raking |
| Primary Settling Tanks |  |  |
| No. of tanks | 2 | 2 |
| Diameter, ft. | 45 | 45 |
| Sidewall water depth, ft. | 8.5 | 8.5 |
| Unit volume, ga. | 101,000 | 101,000 |
| Detention at average flow, hr. | 6.9 | 2.42 |
| Overflow rate at average flow, gal./sq. ft./ day | 220 | 630 |
| Weir rate at average flow, gal./lf/day | 2,490 | 7,100 |

| | Initial 1972 | Design, Year 1990 |
|---|---|---|
| **Aeration Tanks** | | |
| No. of tanks | 4 | 4 |
| Average water depth, ft. | 15 | 15 |
| Overall tank dimensions: | | |
| Length, ft. | 54 | 54 |
| Width, ft. | 30 | 30 |
| Unit volume, cf | 24,300 | 24,300 |
| Total volume, cf | 97,200 | 97,200 |
| No. of tanks in service | 2 | 4 |
| Detention time, hr: | | |
| At average flow | 12.4 | 8.7 |
| At sustained peak flow | 8.3 | 5.6 |
| BOD to aeration tanks, lb/day | 910 | 2,930 |
| Tank loading, lb BOD/1,000 cf | 18.8 | 30.2 |
| MLSS concentration, mg/l | 4,000 | 2,000 |
| Total MLSS in aeration tanks, lb | 12,100 | 12,100 |
| F/M ratio, lb BOD/lb MLSS | 0.075 | 0.24 |
| **Aeration Equipment** | | |
| Oxygen requirement, lb/lb BOD applied | 1.8 | 1.0 |
| Total oxygen required, lb/day: | | |
| Average | 1,640 | 2,930 |
| Peak (150% of average) | 2,460 | 4,400 |
| Aerator capacity, lb oxygen/hp/day (Corrected for temperature, dissolved oxygen level, and K factor) | 44.7 | 44.7 |
| Total horsepower required | | |
| Average | 37 | 65 |
| Peak (150% of average) | 55 | 98 |
| No. of aerators | 8 | 8 |
| Unit horsepower | 15 | 15 |
| Total horsepower | 120 | 120 |
| Total corrected oxygenation capacity installed: | | |
| Lb/day | 5,360 | 5,360 |
| Lb/Lb BOD applied, peak | 3.93 | 1.22 |

| | Initial 1972 | Design Year 1990 |
|---|---|---|
| **Final Settling Tanks** | | |
| Type of sludge removal | suction type | |
| No. of tanks | 2(1) | 2 |
| Diameter, ft. | 40 | 40 |
| Sidewall water depth, ft. | 11.0 | 11.0 |
| Unit volume, gal. | 104,000 | 104,000 |
| Detention at average flow, hr. | 3.56 | 2.50 |
| Overflow rate at average flow, gal./sq. ft./day | 558 | 797 |
| Weir rate at average flow, gal/lf./day | 5,560 | 7,960 |
| **Chlorination System** | | |
| Chlorine Feed: | | |
| Dosage, average mg/l | 8 | 8 |
| Average chlorine demand, lb/day | 46 | 133 |
| Maximum chlorine demand, lb/day | 92 | 266 |
| Chlorinators: | | |
| No. | 2 | 2 |
| Unit capacity, lb./day, maximum | 1,000 | 1,000 |
| Chlorine contact tanks: | | |
| No. | 2 | 2 |
| Unit capacity, cf | 2,800 | 2,800 |
| Detention at instantaneous peak flow, minutes | 42.8 | 15.2 |
| **Sludge Dewatering Facilities** | | |
| Dewatering units | rotary vacuum filter with continuous media wash | |
| No. of filters | 2 | 2 |
| Unit filtration area, sq. ft. | 200 | 200 |
| Total filtration area, sq. ft. | 400 | 400 |
| Solids to filters, lb./wk. | | |
| Average | 9,850 | 35,000 |
| Maximum week | 14,750 | 52,500 |
| Filtration rate, lb/sq.ft./hr. | 2 | 4 |
| Total filtration capacity, lb./hr. | 800 | 1,600 |
| Estimated operating period with all units in service, hr./wk. | | |
| Average | 12 | 23 |
| Maximum week | 19 | 35 |

---

(1) One unit operating.

SAMPLE CONSTRUCTION PHOTO FORM

PHOTO NO. ____ PM FILE NO. ____

CONSTRUCTION PHOTO

PHOTO SHORT TITLE

PHOTO DESCRIPTION: ____________________________________________

________________________________________________________________

________________________________________________________________

DATE TAKEN: ____________________ TIME TAKEN: ____________________

REMARKS: _______________________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

LOCATION OF NEGATIVE: ____________________________________________

________________________________________________________________

| | | |
|---|---|---|
| ENVIRONMENTAL PROTECTION AGENCY<br>**REPORT ON OPERATION AND MAINTENANCE OF WASTEWATER TREATMENT PLANT** | DATE OF INSPECTION | *Form Approved*<br>*OMB No. 158-R0035* |

## A. GENERAL INFORMATION

1. PLANT

| | | |
|---|---|---|
| (a.) NAME | (b.) OWNER | (c.) LOCATION |

| | | | |
|---|---|---|---|
| 2. TYPE OF PLANT | 3. PROJECT NO. | 4. AVG. DESIGN FLOW (*mgd*) | 5. DESIGN POPULATION EQUIVALENT |

| | | |
|---|---|---|
| 6. COLLECTION SYSTEM<br>☐ COMBINED ☐ SEPARATE ☐ BOTH | 7. DATE PRESENT PLANT BEGAN OPERATING | 8. STATE PERMIT NO. |

9. IN THE SPACE PROVIDED BELOW, FURNISH A SIMPLIFIED FLOW DIAGRAM OR A WRITTEN DESCRIPTION OF THE PLANT UNITS IN FLOW SEQUENCE.

10. IDENTIFY RECEIVING WATERS

11. IDENTIFY PERTINENT STREAM STANDARDS AND OR USES OF THE RECEIVING WATERS

12. GIVE THE EFFLUENT STANDARDS AND OR REQUIREMENTS FOR STATE OPERATING PERMIT

## B. CURRENT PLANT LOADING

| | | | |
|---|---|---|---|
| 1. ANNUAL AVG DAILY FLOW RATE (*mgd*) | 2. PEAK FLOW RATE (*mgd*) | | 3. POPULATION SERVED |
| | DRY WEATHER | WET WEATHER | |

| | |
|---|---|
| 4. ANNUAL AVG $BOD_5$ OF RAW SEWAGE (*mg/l*) | 5. ANNUAL AVG SUSPENDED SOLID OF RAW SEWAGE (*mg/l*) |
| 6. PRINCIPAL TYPES OF INDUSTRIAL WASTE DISCHARGED TO MUNICIPAL SYSTEM | 7. POPULATION EQUIVALENT (*BOD*) OF INDUSTRIAL WASTES |
| 8. POPULATION EQUIVALENT (*SS*) OF INDUSTRIAL WASTES | 9. VOLUME OF INDUSTRIAL WASTES (*mgd*) |

10. INFILTRATION PROBLEMS

**EPA Form 7500-5 (4-72)** REPLACES FORM FWPCA-12 WHICH IS OBSOLETE.

☆ GPO : 1972 - 722-098

## C. PLANT PERFORMANCE

1. LABORATORY ANALYSIS (*Total plant*)

(a.) REPORTING PERIOD

FROM (*Month, day, year*)

TO (*Month, day, year*)

| MONTHLY ITEMS (b.) | | FLOW (MGD) | SETTLEABLE SOLIDS (*ml/l*) (c.) | | | SUSPENDED SOLIDS (*mg/l*) (d.) | | | BOD$_5$ (*mg/l*) (e.) | | | PHOSPHORUS AS TOTAL P (*mg/l*) (f.) | | | NITROGEN AS N (*mg/l*) (g.) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | INFLUENT | EFFLUENT | % REMOVAL | INFLUENT | EFFLUENT | % REMOVAL | INFLUENT | EFFLUENT | % REMOVAL | INFLUENT | EFFLUENT | % REMOVAL | INFLUENT | EFFLUENT | % REMOVAL |
| SELECT DATA FROM MONTH HAVING MAXIMUM AVG FLOW<br>MONTH YEAR | MONTHLY AVERAGE FLOW | | | | | | | | | | | | | | | | |
| | DAY OF MAX FLOW (*date*) | | | | | | | | | | | | | | | | |
| | DAY OF MIN FLOW (*date*) | | | | | | | | | | | | | | | | |
| SELECT DATA FROM MONTH HAVING MINIMUM AVG FLOW<br>MONTH YEAR | MONTHLY AVERAGE FLOW | | | | | | | | | | | | | | | | |
| | DAY OF MAX FLOW | | | | | | | | | | | | | | | | |
| | DAY OF MIN FLOW | | | | | | | | | | | | | | | | |

2. LABORATORY ANALYSIS (*Effluent Only*)

| (a.) | | FLOW (MGD) | (b.) DO (*mg/l*) | (c.) CHLORINE RESIDUAL (*mg/l*) | (d.) COLIFORM (*Per 100 ml*) | | (e.) OTHER |
|---|---|---|---|---|---|---|---|
| | | | | | TOTAL | FECAL | |
| SELECT DATA FROM MONTH HAVING MAXIMUM AVG FLOW<br>MONTH YEAR | MONTHLY AVERAGE FLOW | | | | | | |
| | DAY OF MAX FLOW (*date*)______ | | | | | | |
| | DAY OF MIN FLOW (*date*)______ | | | | | | |
| SELECT DATA FROM MONTH HAVING MINIMUM AVG FLOW<br>MONTH YEAR | MONTHLY AVERAGE FLOW | | | | | | |
| | DAY OF MAX FLOW | | | | | | |
| | DAY OF MIN FLOW | | | | | | |

(f.) ARE EFFLUENT STANDARDS ESTABLISHED? ☐ YES ☐ NO

(g.) ARE EFFLUENT STANDARDS BEING MET? ☐ YES ☐ NO

(h.) ARE MONTHLY OPERATING RECORDS FILED WITH STATE AGENCY? ☐ YES ☐ NO

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3. DOES PLANT HAVE ALTERNATE ELECTRIC POWER SOURCE? ☐ DUAL FEED ☐ GENERATOR ☐ NONE

4. ADEQUATE ALARM SYSTEM FOR POWER OR EQUIPMENT FAILURES? ☐ YES ☐ NO

| 5. EQUIPMENT PROGRAM | ADEQUATE | INADEQUATE |
|---|---|---|
| (a.) ROUTINE MAINTENANCE SCHEDULES | | |
| (b.) RECORDS OF MAINTENANCE,REPAIRS & REPLCMT | | |
| (c.) SPARE PARTS INVENTORY | | |

6. IS PLANT EFFLUENT BEING CHLORINATED? ☐ YES ☐ NO

7. DOES SEWAGE BY-PASS PLANT IN WET WEATHER? ☐ YES ☐ NO

8. DOES SEWAGE BY-PASS PLANT IN DRY WEATHER? ☐ YES ☐ NO

9. AGENCIES NOTIFIED OF EACH BYPASS

10. BYPASS FREQUENCY *(Monthly)*

11. AVG DURATION OF BYPASS *(Hrs)*

12. REASON FOR BYPASSING

13. CAN BYPASS SEWAGE BE CHLORINATED? ☐ YES ☐ NO

14. DO SEWER OVERFLOWS OCCUR UPSTREAM OF PLANT? ☐ YES ☐ NO

15. ANY ODOR COMPLAINTS BEYOND PLANT PROPERTY? *(If yes, explain)*

16. OBSERVED APPEARANCE OF EFFLUENT, RECEIVING STREAM OR DRAINAGE WAY

17. IS A CONSULTING ENGINEER RETAINED OR AVAILABLE FOR CONSULTATION ON OPERATING AND MAINTENANCE PROBLEMS? ☐ YES ☐ NO *(If yes, check one of the following)* ☐ CONTINUING BASES ☐ REQUEST BASES

18. DO OPERATORS AND OTHER PERSONNEL ROUTINELY ATTEND SHORT COURSES, SCHOOL OR OTHER TRAINING? ☐ YES ☐ NO

(a.) If yes, cite course sponsor, and date of last course.

(b.) If no, are there any courses available in this area?

(c.) Is there an established procedure for training new operators?

19. IS LAB TESTING ADEQUATE FOR THE CONTROL REQUIRED FOR THIS SIZE AND TYPE OF PLANT AND USES OF RECEIVING WATERS? ☐ YES ☐ NO *(If No, explain)*

20. EXPLAIN MAIN DIFFICULTY EXPERIENCED WITH INDUSTRIAL WASTES

21. PERMANENT RECORD FILE

(a.) PLANT OPERATION AND MAINTENANCE MANUAL? ☐ YES ☐ NO (b.) AS BUILT PLANS AND SPECIFICATIONS? ☐ YES ☐ NO

(c.) MANUFACTURERS OPERATION & MAINTENANCE SPECIFICATIONS? ☐ YES ☐ NO (d.) FLOW CHARTS? ☐ YES ☐ NO

22. ESTIMATED WEEKLY MAN-HOURS FOR LAB WORK INCLUDING MAINTENANCE OF RECORDS AND PREPARATION OF REPORTS

23. ANNUAL BUDGET FOR MAINTAINING AND OPERATING PLANT

| SALARIES & WAGES | ELECTRICITY | CHEMICALS | MAINTENANCE | STAFFING & TRAINING | OTHER | TOTAL |
|---|---|---|---|---|---|---|
| | | | | | | |

24. STABILIZATION PONDS

(a.) WEEDS CUT AND VEGETATION GROWTH IN PONDS REMOVED? ☐ YES ☐ NO

(b.) BANKS AND DIKES MAINTAINED? *(Erosion, etc.)* ☐ YES ☐ NO

(c.) ANY REPORTS OF GROUND WATER CONTAMINATION FROM POND? *(If yes, give details)* ☐ YES ☐ NO

(d.) SEEPAGE REPORTED? ☐ YES ☐ NO

(e.) ADEQUATE DEPTH CONTROL? ☐ YES ☐ NO

(f.) EFFLUENT RELEASE IS ☐ CONTINUOUS ☐ INTERMITTENT ☐ SEASONAL

* GPO 1972 552-394

## D. LABORATORY CONTROL

### CODING INSTRUCTION

Enter test codes opposite appropriate items. If any of the below tests are used to monitor industrial wastes, place an "X" in addition to the test code.

| | | | | |
|---|---|---|---|---|
| 1 - 7 or more per week | 3 - 1, 2 or 3 per week | 5 - 2 or 3 per month | 7 - Quarterly | 9 - Annually |
| 2 - 4, 5 or 6 per week | 4 - as required | 6 - 1 per month | 8 - Semi-Annually | |

| ITEM<br>(a.) | RAW<br>(b.) | PRIMARY EFFLUENT<br>(c.) | MIXED LIQUOR<br>(d.) | FINAL<br>(e.) | (f.) SLUDGE | | DIGESTER<br>(g.) | RECEIVING STREAM<br>(h.) |
|---|---|---|---|---|---|---|---|---|
| | | | | | RAW | SUPER-NATANT | | |
| 1. BOD | | | | | | | | |
| 2. SUSPENDED SOLIDS | | | | | | | | |
| 3. SETTLEABLE SOLIDS | | | | | | | | |
| 4. SUSPENDED VOLATILE | | | | | | | | |
| 5. DISSOLVED OXYGEN | | | | | | | | |
| 6. TOTAL SOLIDS | | | | | | | | |
| 7. VOLATILE SOLIDS | | | | | | | | |
| 8. pH | | | | | | | | |
| 9. TEMPERATURE | | | | | | | | |
| 10. COLIFORM DENSITY | | | | | | | | |
| 11. RESIDUAL CHLORINE | | | | | | | | |
| 12. VOLATILE ACIDS | | | | | | | | |
| 13. M B STABILITY | | | | | | | | |
| 14. ALKALINITY | | | | | | | | |
| 15. | | | | | | | | |
| 16. | | | | | | | | |
| 17. | | | | | | | | |
| 18. | | | | | | | | |
| 19. | | | | | | | | |

COMMENTS

## E. PLANT PERSONNEL INVENTORY

| PERSONNEL CLASSIFICATION<br>(a.) | EMPLOYMENT<br>(b.) | | | | (c.) CERTIFICATION<br>VOLUNTARY ☐<br>MANDATORY ☐ | | TRAINING REQUIRED NEXT 12 MONTHS<br>(d.) | |
|---|---|---|---|---|---|---|---|---|
| | ACTUAL | | NUMBER BUDGETED | NO. RE-COMMENDED | NO. RECOM-MENDED OR REQUIRED BY STATE | ACTUAL NO. CERTIFIED | NEW HIRES | UPGRADE *(Promotion or skill improvement* |
| | MAN-HOURS PER WEEK | NUMBER | | | | | | |
| 1. MANAGEMENT/SUPERVISOR | | | | | | | | |
| 2. OPERATOR | | | | | | | | |
| 3. LABORATORY | | | | | | | | |
| 4. MAINTENANCE | | | | | | | | |
| 5. OTHER PLANT WORKERS | | | | | | | | |
| 6. OTHER OFFICE/CLERICAL | | | | | | | | |
| 7. TOTAL | | | | | | | | |

★ GPO: 1972-722-093

## F. GUIDE - VISUAL OBSERVATION - UNIT PROCESS

**RATING CODES:** S = Satisfactory; U = Unsatisfactory; M = Marginal; IN = In Operation; OUT = Out of Operation

| | CONDITION OR APPEARANCE | RATING | COMMENTS |
|---|---|---|---|
| GENERAL | GROUNDS | | |
| | BUILDINGS | | |
| | POTABLE WATER SUPPLY PROT | | |
| | SAFETY FEATURES | | |
| | BYPASSES | | |
| | STORM WATER OVERFLOWS | | |
| | | | |
| | | | |
| PRELIMINARY | MAINTENANCE OF COLLECTION SYSTEMS | | |
| | PUMP STATION | | |
| | VENTILATION | | |
| | BAR SCREEN | | |
| | DISPOSAL OF SCREENINGS | | |
| | COMMINUTOR | | |
| | GRIT CHAMBER | | |
| | DISPOSAL OF GRIT | | |
| | | | |
| | | | |
| PRIMARY | SETTLING TANKS | | |
| | SCUM REMOVAL | | |
| | SLUDGE REMOVAL | | |
| | EFFLUENT | | |
| | | | |
| | | | |
| SLUDGE DISPOSAL | DIGESTERS | | |
| | TEMPERATURE AND pH | | |
| | GAS PRODUCTION | | |
| | HEATING EQUIPMENT | | |
| | SLUDGE PUMPS | | |
| | DRYING BEDS | | |
| | VACUUM FILTER | | |
| | INCINERATION | | |
| | DISPOSAL OF SLUDGE | | |
| | | | |
| | | | |
| OTHER | FLOWMETER AND RECORDER | | |
| | RECORDS | | |
| | LAB CONTROLS | | |
| | | | |
| | | | |
| SECONDARY-TERTIARY *(List items as required)* | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| CHLORINE | EFFLUENT | | |
| | CHLORINATORS | | |
| | EFFECTIVE DOSAGE | | |
| | CONTACT TIME | | |
| | CONTACT TANK | | |
| | | | |
| | | | |

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## G. NOTATIONS BY EVALUATOR

1. ARE THERE ANY PENDING ACTIONS *(Enforcement Conference, change in Water Quality Standards, etc.)* THAT WOULD REQUIRE UPGRADING OF TREATMENT BY THIS PLANT? ☐ YES ☐ NO *(If yes, explain)*

2. IS ANY FOLLOW-UP ACTION REQUIRED TO: (1) CORRECT DEFICIENCIES IN THE PLANT OR ITS OPERATION, (2) RESOLVE INDUSTRIAL WASTE PROBLEMS, (3) STAFF DEFICIENCIES OR TRAINING NEEDS? ☐ YES ☐ NO *(If yes, describe)*

3. IS PURPOSE OF INSPECTION TO DETERMINE IF NEW CONSTRUCTION COMPLIES WITH FEDERAL REQUIREMENTS FOR THE PROVISION OF AN OPERABLE FACILITY? ☐ YES ☐ NO

| 4. GENERAL RATING | |
|---|---|
| ACCEPTABLE | ☐ |
| CONDITIONAL ACCEPTANCE | ☐ |
| UNACCEPTABLE | ☐ |

| EVALUATION PERFORMED BY | TITLE | ORGANIZATION | DATE |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

| INFORMATION FURNISHED BY | TITLE | ORGANIZATION | DATE |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

☆ GPO: 1972 — 722-091

# PAINTING

The required frequency of painting depends on several factors, the most important being (1) severity of environment, and (2) the quality of paint system applied and adequacy of surface preparation and application. Generally speaking, concrete and metal surfaces that are submerged or otherwise located in severe environmental areas that have properly applied quality coatings, should not need repainting more often than annually. This frequency may increase in coastal areas or other areas exposed to high concentrations of salts. Properly protected equipment and surfaces in protected areas should not need repainting more often than every three years. Spot painting should be performed as needed.

The following is a list of suggested painting systems for various exposure conditions:

## Painting

| Exposure Condition | Paint Type |
|---|---|
| 1. Steel exposed to weather, high himidity, and industrial atmosphere. | Primer:<br>1. Iron oxide and/or red lead - zinc chromate - alkyd varnish.<br>2. Coal tar derivative (no top coats)<br>Top Coats:<br>Alkyd |
| 2. Steel continuously immersed or wetted | Primer:<br>1. Iron oxide and/or red lead - zinc chromate - phenolic primer. |

| Exposure Condition | Paint Type |
|---|---|
|  | 2. Coal tar derivative |
|  | Top Coats:<br>1. Phenolic.<br>2. Coal Tar Enamel |
| 3. Surfaces subject to abrasion. | Neoprene<br>Short-oil alkyd<br>Phenolic<br>Vinyl |
| 4. Galvanized iron | Primer:<br>Zinc-dust-zinc oxide |
|  | Top Coats:<br>Conventional |
| 5. Concrete | Cement-water paints (above water)<br>Resin-emulsion paints (above water)<br>Chlorinated-rubber paints (below water)<br>Coal Tar Products (below water) |

# REFERENCES TO BE MAINTAINED AT TREATMENT FACILITY

## INITIAL MINIMUM REFERENCES

### Water Pollution Control Federation Publications

MOP #1 Safety in Wastewater Works
MOP #11 Operation of Wastewater Treatment Plants
MOP #18 Simplified Lab Procedures For Wastewater Examination

### Other References

Standard Method For The Examination of Water & Wastewater
WPCF, APHA & AWWA

Glossary of Terms, WPCF, APHA, ASCE & AWWA

Manual of Wastewater Operations, Texas Water Utilities Association and/or Manual of Instruction For Sewage Treatment Plant Operators, New York State Department of Health.

Operation of Wastewater Treatment Plants, EPA Grant No. 5TT1-WP-16-03, Prepared by Sacramento State College, Dept. of Civil Engineering.

Chlorine Manual, Chlorine Institute

## RECOMMENDED SUPPLEMENTARY REFERENCES

Depending on the size and complexity of the treatment facility, any or all of the following references should be provided. These references would be in addition to the list given above:

Water Pollution Control Federation Publications

MOP #2 Sludge Utilization
MOP #5 Aeration in Wastewater Treatment
MOP #7 Sewer Maintenance
MOP #10 Uniform System of Accounts for Wastewater Utilities
MOP #16 Anaerobic Sludge Digestion
MOP #17 Paints & Protective Coatings
MOP #20 Sludge Dewatering
Public Relations Handbook

Text Books

Sawyer, C. H. and McCarty, P. L., Chemistry for Sanitary Engineers, McGraw-Hill, 1967.

Metcalf & Eddy, Inc., Wastewater Engineering: Collection, Treatment and Disposal, McGraw-Hill, 1972.

EPA Manuals

Procedural Manual for Evaluating The Performance of Wastewater Treatment Plants, Contract No. 68-01-0107.

Middle Management Concepts for Municipal Wastewater Operations, Contract No. 68-01-0341.

Start-up of Municipal Wastewater Treatment Plants, Contract No. 68-01-0341.

Emergency Operating Procedures for Municipal Wastewater Facilities, Contract No. 68-01-0341.

EPA Manuals (Continued)

Methods for Chemical Analysis of Water and Waste, GPO Stock No. 5501-0067.

## SECTION XX

## O & M MANUAL PREPARATION COST GUIDELINES

The O & M Manuals currently being produced vary widely in their preparation costs. Not only do these costs vary with the size and complexity of each facility, but there are also wide variations among similar facilities. The primary reason for these cost variations is the detail of each manual.

The man-hour estimates contained in this section are not based on a statistical study. Input on manual preparation costs was obtained from consulting engineers involved in this work. These estimates are broken down by the recommended chapters to be included in an O & M Manual. The man-hour requirements used in these guidelines are not intended to represent national or regional averages and are based on information gathered during this manual's preparation.

Base Plant - To illustrate a typical cost breakdown, an ideal plant was selected as a base from which estimations of O & M Manual preparation costs for facilities of various types and sizes could be made. The following is a description of the base plant selected:

Plant Type: Conventional Activated Sludge
Plant Size: 10 MGD
Sludge Handling Facilities: Anaerobic Digestion
Vacuum Filtration
Landfilling

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## BASE PLANT

## O & M MANUAL COST GUIDELINES

| Manual Chapter Title | | Man-hours | Title |
|---|---|---|---|
| I. | Introduction<br>&<br>Permits and Standards | 40 | Project Engineer |
| II. | | 20 | Technician |
| | | 5 | Typist |
| III. | Description, Operation and Control of Wastewater Treatment Facilities | 80 | Project Engineer |
| | | 40 | Technician |
| | | 10 | Typist |
| IV. | Description, Operation and Control of Sludge Handling Facilities | 80 | Project Engineer |
| | | 40 | Technician |
| | | 10 | Typist |
| V. | Personnel | 20 | Project Engineer |
| | | 5 | Technician |
| | | 5 | Typist |
| VI. | Laboratory Testing | 20 | Project Engineer |
| | | 10 | Technician |
| | | 5 | Typist |
| VII. | Records | 20 | Project Engineer |
| | | 10 | Technician |
| | | 5 | Typist |
| VIII. | Maintenance | 80 | Project Engineer |
| | | 40 | Technician |
| | | 10 | Typist |
| IX. | Emergency Operating and Response Program | 40 | Project Engineer |
| | | 20 | Technician |
| | | 5 | Typist |
| X. | Safety | 40 | Project Engineer |
| | | 10 | Technician |
| | | 5 | Typist |
| XI. | Utilities | 20 | Project Engineer |
| | | 5 | Technician |
| | | 5 | Typist |

|  |  |  |  |
|---|---|---|---|
| XII. | Electrical System | 80 | Project Engineer |
|  |  | 40 | Technician |
|  |  | 10 | Typist |
| XIII. | Appendix | 40 | Project Engineer |
|  |  | 20 | Technician |
|  |  | 5 | Typist |
|  | MISCELLANEOUS |  |  |
|  | Project Management | 60 | Project Manager |
|  | Manual Review | 20 | Director |
|  |  | 20 | Project Manager |
|  | Checking/Proofing Manual | 20 | Project Manager |
|  | Printing/Binding |  |  |

The hourly rates to be used with the man-hours given in these guidelines will have to be adjusted to reflect existing salaries. Salaries vary with geographic location and various other factors. The following references can be used to assist in making realistic manual preparation cost estimates:

| JOB DESCRIPTION | REFERENCE | REMARKS |
|---|---|---|
| Professional Engineers | Income and Salary Survey National Society of Professional Engineers (NSPE) | Biennial report on the findings of a national salary survey conducted by NSPE. Respondents to survey are all members of NSPE. |
| Engineering Technicians | Salaries of Engineering Technicians, Engineering Manpower Commission, Engineers Joint Council (EJC) | Biennial Report on the findings of a national survey conducted by EJC. |
| Typist | State Employment Commission, Wage Rates For Selected Occupations | State Employment Commissions usually publish yearly compilation of salary surveys. |

Complexity Factors

In order to estimate the O & M Manual preparation cost for a particular size and type facility, this cost must be related to the "Base Plant" described previously. An attempt has been made to relate this base plant cost figure to other size and type plants through the use of "complexity factors" displayed in Table No. 2. Complexity factors have been developed for three basic wastewater treatment plant types:

primary*, trickling filter and activated sludge. Under each of these plant types, the sludge handling has been broken down to three major methods:

1. Digestion
   Drying Beds/Lagoons

2. Digestion
   Vacuum Filtration

3. Vacuum Filtration
   Incineration

* NOTE: Although no primary plants will be constructed in the future, there can be plant expansions that will only affect the primary treatment facilities and sludge handling facilities.

The complexity factors are related to the following plant sizes: 1 MGD, 10 MGD, 50 MGD and 100 MGD.

The estimate of manual preparation cost is made by multiplying the "Base Plant" cost figure times the complexity factor for the particular size and type plant under consideration.

EXAMPLE:

Plant Type: Activated Sludge
Plant Size: 1 MGD
Sludge Handling: Anaerobic Digestion
Drying Beds

From Table No. 2C, the complexity factor is 0.39

Assume Base Plant Manual cost is estimated at $16,330.00

O & M Manual Preparation Cost = (Base Plant Cost) x (Complexity Factor)
= $16,330.00 x 0.39
= $6,400.00

It should be remembered that the total cost figures arrived at using these guidelines do not represent national averages and the cost figures should be thought of as being within a range of preparation cost for a particular manual.

COMPLEXITY FACTORS PRIMARY PLANTS

| WASTEWATER TREATMENT | 1 MGD | 10 MGD | 50 MGD | 100 MGD |
|---|---|---|---|---|
| Primary | | | | |
| Wastewater Treatment | | | | |
| Raw wastewater pumping<br>Pretreatment Primary<br>Sedimentation Chlorination | | | | |
| Sludge Handling | | | | |
| Primary sludge pumping<br>Sludge digestion<br>Sludge drying beds<br>or<br>Sludge lagoons | 0.35 | 0.79 | 1.78 | 2.94 |
| Primary sludge pumping<br>Sludge digestion<br>Sludge holding tanks<br>Vacuum filtration | 0.41 | 0.89 | 1.88 | 3.13 |
| Primary sludge pumping<br>Sludge holding tanks<br>Vacuum filtration<br>Incineration | 0.45 | 0.93 | 1.98 | 3.25 |

TABLE NO. 2A

COMPLEXITY FACTORS TRICKLING FILTER

| WASTEWATER TREATMENT | 1 MGD | 10 MGD | 50 MGD | 100 MGD |
|---|---|---|---|---|
| Trickling Filter | | | | |
| Wastewater Treatment | | | | |
| Raw wastewater pumping<br>Pretreatment Primary<br>Sedimentation Trickling<br>Filters<br>Final sedimentation<br>Recirculation pumping<br>Chlorination | | | | |
| Sludge Handling | | | | |
| Primary sludge pumping<br>Sludge digestion<br>Sludge Drying beds<br>or<br>Sludge lagoons | 0.36 | 0.83 | 1.86 | 3.07 |
| Primary sludge pumping<br>Sludge digestion<br>Sludge holding tanks<br>Vacuum filtration | 0.43 | 0.93 | 1.96 | 3.27 |
| Primary sludge pumping<br>Sludge holding tanks<br>Vacuum filtration<br>Incineration | 0.47 | 0.98 | 2.06 | 3.40 |

TABLE NO. 2B

## COMPLEXITY FACTORS ACTIVATED SLUDGE

| WASTEWATER TREATMENT | 1 MGD | 10 MGD | 50 MGD | 100 MGD |
|---|---|---|---|---|
| Activated | | | | |
| Wastewater Treatment | | | | |
| Raw wastewater pumping<br>Pretreatment Primary sedimentation<br>Aeration<br>Final sedimentation<br>Recirculation pumping<br>Chlorination | | | | |
| Sludge Handling | | | | |
| Primary sludge pumping<br>Sludge digestion<br>Sludge drying beds<br>or<br>Sludge lagoons | 0.39 | 0.89 | 2.0 | 3.31 |
| Primary sludge pumping<br>Sludge digestion<br>Sludge holding tanks<br>Vacuum filtration | 0.46 | 1.0* | 2.11 | 3.52 |
| Primary Sludge pumping<br>Sludge holding tanks<br>Vacuum filtration<br>Incineration | 0.50 | 1.05 | 2.22 | 3.66 |

TABLE NO. 2C

*BASE PLANT

# SECTION XXI

# ACKNOWLEDGEMENTS

The data received through personal communications with wastewater treatment plant superintendents, consulting engineers and operation and maintenance staff personnel with the EPA is gratefully acknowledged.

The support of the project by the Office of Water Programs Operations, U.S. Environmental Protection Agency, and the help provided by Mr. Royal C. Thayer, the Project Officer, is acknowledged with appreciation.

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## SECTION XXII

## REFERENCES

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2. Comptroller General of the United States, Report to the Congress, Need for Improved Operation and Maintenance of Municipal Waste Treatment Plants, Date Sept. 1, 1970.

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The attached tabulation gives references for each of the chapters recommended for an O & M Manual.

| EPA MANUALS / O & M MANUAL CHAPTERS | INTRODUCTION | PERMITS & STANDARDS | DESCRIPTION, OPERATION & CONTROL OF WASTEWATER TREATMENT FACILITIES | DESCRIPTION, OPERATION & CONTROL OF SLUDGE HANDLING FACILITIES | PERSONNEL | LABORATORY TESTING | RECORDS | MAINTENANCE | EMERGENCY OPERATING AND RESPONSE PROGRAM | SAFETY | UTILITIES | ELECTRICAL SYSTEM | APPENDICES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Considerations For Preparation of Operation and Maintenance Manuals | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Procedural Manual For Evaluating The Performance of Wastewater Treatment Plants | | | X | X | X | X | | X | | | | | |
| Estimating Laboratory Needs for Municipal Wastewater Treatment Facilities | | | | | X | X | X | | | | | | |
| Estimating Costs and Manpower Requirements for Conventional Wastewater Treatment Plants | | | | | X | | X | | | | | | |
| Estimating Staffing for Municipal Wastewater Facilities | | | | | X | | | | | | | | |
| Maintenance Management Systems for Municipal Wastewater Facilities | | | | | X | | X | X | | | | | X |
| Emergency Operating Procedures For Municipal Wastewater Treatment Facilities | | | X | X | | | | | X | | | | |
| A Planned Maintenance Management Program | | | | | | | | X | | | | | |
| Emergency Response Program For Municipal Wastewater Treatment Facilities - State and Local Aspects | | | | | | | | | X | | | | |
| Safety In The Design, Operation and Mantenance of Wastewater Treatment Works | | | | | | | | | | X | | | |

| O & M MANUAL CHAPTERS | INTRODUCTION | PERMITS & STANDARDS | DESCRIPTION, OPERATION & CONTROL OF WASTEWATER TREATMENT FACILITIES | DESCRIPTION, OPERATION & CONTROL OF SLUDGE HANDLING FACILITIES | PERSONNEL | LABORATORY TESTING | RECORDS | MAINTENANCE | EMERGENCY OPERATING AND RESPONSE PROGRAM | SAFETY | UTILITIES | ELECTRICAL SYSTEM | APPENDICES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA MANUALS (CONTINUED) | | | | | | | | | | | | | |
| Start-up of Municipal Wastewater Treatment Facilities | | | X | X | | | | | | | | | |
| Middle Management Concepts for Municipal Wastewater Operations | X | | | | | | | | | | | | |
| WATER POLLUTION CONTROL FEDERATION | | | | | | | | | | | | | |
| MOP #1 Safety In Wastewater Works | | | | | | | | | | X | | | |
| MOP #3 Regulation of Sewer Use | | | | | | | | | | | | | X |
| MOP #7 Sewer Maintenance | | | | | | | | X | | | | | |
| MOP #11 Operation of Wastewater Treatment Plants | X | | X | X | X | X | X | X | | X | X | X | X |
| MOP #17 Paints and Protective Coatings | | | | | | | | | | | | | X |
| Publication #18 Simplified Lab Procedures For Wastewater Examination | | | X | X | | X | | | | | | | X |
| Standard Methods For Examination of Water & Wastewater 13th Edition | | | X | X | | X | | | | | | | X |

| O & M MANUAL CHAPTERS | INTRODUCTION | PERMITS & STANDARDS | DESCRIPTION, OPERATION & CONTROL OF WASTEWATER TREATMENT FACILITIES | DESCRIPTION, OPERATION & CONTROL OF SLUDGE HANDLING FACILITIES | PERSONNEL | LABORATORY TESTING | RECORDS | MAINTENANCE | EMERGENCY OPERATING AND RESPONSE PROGRAM | SAFETY | UTILITIES | ELECTRICAL SYSTEM | APPENDICES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MISCELLANEOUS REFERENCES | | | | | | | | | | | | | |
| Manual of Wastewater Operations, Texas Water Utilities Association | X | | X | X | X | X | X | X | | X | X | X | X |
| Manual of Instruction For Sewage Treatment Plant Operators, New York State Department of Health | X | | X | X | X | X | X | X | | X | X | X | X |
| Chlorine Manual Chlorine Institute | | | X | | | | | | | X | | | |

# SECTION XXIII

# APPENDICES

## ASSOCIATED EPA PROGRAMS

The Environmental Protection Agency is developing several manuals to assist in the proper operation and maintenance of municipal wastewater treatment plants. These manuals may be useful in preparing an O & M Manual.

A Planned Maintenance Management Program, Project No. 11010 GWI

Estimating Staffing for Municipal Wastewater Treatment Facilities, Contract No. 68-01-0328.

Estimating Laboratory Needs For Municipal Wastewater Treatment Facilities, Contract No. 68-01-0328

Emergency Operating Procedures for Municipal Wastewater Treatment Facilities, Contract No. 68-01-0341

Maintenance Management Systems for Municipal Wastewater Facilities, Contract No. 68-01-0341

Emergency Response Program for Municipal Wastewater Treatment Facilities - State and Local Aspects, Contract No. 68-01-0341

Start-up of Municipal Wastewater Treatment Plants, Contract No. 68-01-0341

Middle Management Concepts for Municipal Wastewater Operations, Contract No. 68-01-0341

Procedural Manual for Evaluating The Performance of Wastewater Treatment Plants, Contract No. 68-01-0107

Safety In The Design, Operation and Maintenance of Wastewater Treatment Works, Contract No. 68-01-0324

Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability, Contract No. 68-01-0001.

Methods for Chemical Analysis of Water and Waste, GPO Stock No. 5501-0067.

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